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## STUDIES OF CENTRAL AMERICAN REDSTARTS

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NORTH American wood warblers are highly migratory, exhibit pronounced sexual differences in coloration, and often show marked seasonal changes in plumage. So numerous are these delightful little birds in temperate North America that one is likely to forget that the family is best represented in tropical America, where the species, though few at sea-level, become ever more numerous with increasing elevation. These tropical members of the family are typically non-migratory; even among the most brilliant of them the sexes are often alike or nearly so; seasonal changes in coloration are exceptional if not entirely absent; and, as a corollary, the young birds, in many species at least, acquire the adult plumage in the postjuvenal rather than in the prenuptial molt.

During the two years I spent in bird study in the Central American highlands (1933 in Guatemala, 1937-38 in Costa Rica), I was able to learn something of the habits of three forms of *Myioborus*, a genus of brightly colored wood warblers occurring from Mexico to Bolivia, chiefly in the subtropical zone, but sometimes also in the tropical and temperate zones. Unfortunately, limitations of time prevented my making any of these three forms a major study—interesting as these birds were, they seemed in less urgent need of investigation than some of the neighboring birds of non-passerine families, which in general are less well known than the wood warblers. Yet so far as I am aware, almost nothing has been published concerning the life history of the tropical warblers, and it is to help bridge this gap in our knowledge of the family that these notes are presented. Although none of the three life histories can claim even approximate completeness, they seem to complement one another; taken together they give a fair picture of the lives of these attractive mountain forest birds.

### PACIFIC ORANGE-BELLIED REDSTART

The Pacific Orange-bellied Redstart (*Myioborus miniatus hellmayri*) is a northern representative of a group of wood warblers widely distributed in the mountainous regions of Central America and



*Near Tecpán, Guatemala*

*May 15, 1933*

*Nest of the Pacific Orange-bellied Redstart*

*(Myioborus miniatus hellmayri)*

tropical South America. The species is known to range from Mexico to Peru, and several races have been described; *hellmayri*<sup>1</sup> is confined to the western highlands of Guatemala and extreme southwestern El Salvador. In Guatemala, I met it at many points, and in 1933 found its nest on the Sierra de Tecpán, Department of Chimaltenango, at an altitude of about 8,500 feet. I have seen it at points ranging from 2,000 to 9,500 feet above sea-level, although at both of these extremes of elevation it is rare. It is particularly abundant in the heavy, humid forests at middle altitudes on the Pacific slope, from 5,000 to 7,000 feet above sea-level, as, for example, on the wooded flanks of the Volcán Zunil opposite Santa María de Jesús, where in July and August, 1934, I found it among the most conspicuous members of the avifauna.

*Appearance and habits.* This warbler is a bird of striking and distinctive appearance. Most of its head, its back, wings, and most of the tail, throat, and the sides of its breast, are dark slate-color; the center of the crown is chestnut; and the outer tail feathers are broadly tipped with white; most of the breast and the belly are a beautiful bright color, something between orange and red—almost the shade of a tangerine orange. The male and female are colored so nearly alike that it is usually not possible to recognize any difference in their brightness unless one sees them side by side.

This restlessly active little bird catches a large part of its insect food upon the wing. It flits airily amid the foliage, or with consummate deftness weaves an intricate course among the branches, to reach some insect it has seen in a distant part of the tree; or it darts swiftly in pursuit of some creature that has taken flight, twisting, turning, and doubling in the air with amazing skill. In its quieter intervals of hopping and jumping among the branches it often droops its wings, and spreads its tail, displaying the broad white tips of the outer feathers, which contrast prettily with the dark slaty color of the others.

Except during the breeding season, an individual of this subspecies strictly avoids the company of its own kind but attaches itself to one of the large mixed flocks of wood warblers and other small birds that roam through the highland forests, in each of which there is usually a single Orange-bellied Redstart. Here it is conspicuous by reason of its spectacular flight, its flaming breast, and its habit of continually spreading its tail. As the breeding season approaches, the males attract still

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<sup>1</sup>The eggs and nestlings noted under "*Myioborus miniatus connectens*" in my paper on incubation and nestling periods (*Auk*, 62, 1945:23) are from the nest described here under "*Myioborus miniatus hellmayri*." The editor followed Hellmayr ("Birds of the Americas") in using "*connectens*" for the Guatemalan form. But van Rossem in his revision of the species (*Condor*, 38, 1936:117-118) calls the form that occurs in western Guatemala and extreme southwestern El Salvador "*M. miniatus hellmayri*, Pacific Orange-bellied Redstart" and limits the smaller *connectens* to the mountains of the interior Cordillera of El Salvador and south central Honduras, pointing out that Hellmayr had only two birds from the range of *connectens*, so that the size differences were not apparent. It is unfortunate that my two papers should not agree in nomenclature, but to avoid a more general confusion it seems best to follow van Rossem here.

further attention by their song. Although simple in phrasing, it is loud, clear, and ringing—the most forceful of all the songs of warblers I heard on the Sierra de Tecpán, except only that of the Painted Redstart (*Setophaga picta*).

*Nest and eggs.* On the afternoon of May 13, 1933, while climbing a steep, wooded slope on the Sierra de Tecpán, beneath fine, old, epiphyte-laden trees, I stumbled over a decaying log and frightened a small, blackish-backed bird from its nest. It flew off so rapidly that I saw it too imperfectly to be able to identify it. The nest was situated on the uphill side of a large depression in the ground, made by the uprooting of a great tree whose massive trunk lay mouldering on the slope below. The tree must have fallen some years earlier, for the sides of the hollow were already well-covered with ferns and mosses, and among these the nest was concealed. The structure consisted of a cup-shaped lower portion and a domed roof. The entrance, in the side facing out from the bank, was not round like that of the nests of other forms of *Myioborus* that I found in later years in Costa Rica, but very much wider than high. The lower cup was composed of dead leaves and fibers, thickly lined with fine fibrous material; but the substantial roof, which seemed to have been added as a separate unit, consisted largely of pine needles, with a few dead leaves of dicotyledonous plants intermixed. The three beautiful eggs that rested on the bottom of the nest were white, heavily speckled with reddish-brown, especially on the thicker end; they measured respectively 17.5 by 13.5, 17.5 by 13.5, and 17.5 by 13.1 millimeters. The tip of a frond of a small fern, rooted higher on the bank, hung prettily over the entrance, partially screening the eggs (Plate 12). Dickey and van Rossem (1938:506) describe a nest of this redstart found in El Salvador, May 17, 1927, which "was in a crevice in a vertical road bank, the site being about three feet above the road level. It was simply a ball of bright green moss which entirely filled the cavity, and the outer surface of the nest was flush with the face of the bank. The entrance was a small hole in the side. The lining was of rather wide strips of what appeared to be soft inner bark. A sheltering curtain of ferns hung down over the nest entrance, and the site was discovered only by watching the parents as they carried food to the young."

I waited till evening was approaching for the bird to come back to the nest, but it seemed reluctant to show itself in my presence. Returning on the following day, I was delighted to find an Orange-bellied Redstart sitting in the domed nest. The bird allowed me to approach almost within reach before it jumped out and flew down the slope, skimming low over the ground. I set up my tent in the depression, not two yards from the nest, for there was no other level spot in the vicinity. I seated myself inside and looked out through the tiny window for the Redstart's return. Promptly re-appearing, the bird fluttered back and forth in front of the nest, apparently not sure whether it would be quite safe to go to

it in the presence of the strange brown object that had so suddenly sprung up there. Many times the Redstart approached the nest and seemed to be on the point of entering but retreated before quite reaching the goal. Finally, 10 minutes after I entered the blind, the bird was warming the eggs once more.

The next step was to mark one of the pair of Redstarts, in order to distinguish male from female with certainty. After the bird's departure from the nest, I stuck upright in the middle of the doorway a fine twig bearing a wad of cotton soaked in white enamel. Once more the bird flew back and forth in front of the nest; sometimes it alighted on a dead branch which projected from the bank just outside the blind, proving thereby that it had already lost all distrust of this strange object. Finally, before many minutes had passed, the Redstart returned to the nest and attempted to slip into it between the little paintbrush and one corner of the wide entrance but brushed lightly against the paint-soaked cotton. This seemed to disturb the bird greatly; it slipped out immediately and at once began to preen the feathers on the left side of the orange breast, where a small spot of white marred the uniform brightness. The mark was hardly conspicuous enough to satisfy me, and the Redstart was doing its best to make it less so; accordingly I left the brush in place so that the bird might make contact with it once more. Although I left it there for more than half an hour, the Redstart did not go near, and finally disappeared with another Redstart, assumed to be the male of the pair, which, during all this time, had not come near the nest but remained at a distance among the trees. Since it was now after five o'clock in the afternoon, I removed the paint-brush and went away, leaving the blind in place for the morrow.

*Incubation.* The following morning, May 15, in the early dawn, I slipped into the brown wigwam without disturbing the Redstart and passed the greater part of the day watching the nest. The marked bird, evidently the female, alone warmed the eggs. On returning at the end of a recess, she always flew back and forth a number of times in front of the nest, and often made several false starts to enter it. Her hesitation in going to the nest was probably not caused by the presence of the blind, for in these maneuvers she often came very close to it, and many times perched on a dead branch just outside, not two feet from my eyes. Thereby I had ample opportunity to recognize the faint paint mark on her left side, and did so at every return to the nest except three.

The Redstart sat sideways in the nest, with her long tail projecting from one corner of the wide entrance and her head constantly turned outward so that she could view her surroundings. Her bright orange-red breast and belly were concealed beneath her, and the white ends of her outer tail feathers were folded under the uniformly dark central feathers; in the nest, she was far less conspicuous than one would suppose to be possible. During the night and in rainy weather, she sat

with her left wing toward the outside; but during clear days she always sat facing in the opposite direction, with her right wing outward. Since there was little, if any, wind in the deep forest where the nest was situated, I cannot explain this invariable habit. Most of the time she rested nearly motionless, seldom turning her head or adjusting the eggs beneath her; but she was ever alert to slight sounds and looked about to discover their origin. Some minutes before leaving the nest she would become restless, move her head actively, swallow, gape, and shift the eggs; these movements would lead at length to her flying off. As she winged down the mountainside, she invariably called, with sharp, metallic monosyllables very similar to the call of the Cardinal (*Richmondia cardinalis*).

I devoted a total of 12 hours to watching this Redstart incubate. From 5:40 A.M. to 2:26 P.M. on May 15, I kept vigil during weather which was largely cloudy but rainless; while from 2:55 to 6:00 P.M. on May 17 I studied her behavior in a steady, fairly hard rain. Taking the two records together, 11 sessions on the eggs ranged from 26 to 49 minutes, with an average of 37.6 minutes; 12 recesses ranged from 10 to 37 minutes, with an average of 18.2 minutes. She devoted 67.4 per cent of the 12 hours to incubation. I have not included in this record a session of only 18 minutes which was terminated when a jaguarundi cat passed stealthily, only two yards in front of the nest, and frightened the Redstart from her eggs.

It is of interest to compare the Redstart's behavior while incubating in clear weather and in the rain. During the rainy afternoon of May 17, there were two sessions of 42 and 49 minutes, respectively, and two recesses of 37 and 35 minutes. Her sessions on the eggs were not significantly longer than those in clear weather; for early in the rainless afternoon of May 15 she sat continuously for periods of 47, 38, and 45 minutes, while early in the morning she had incubated once for 38 minutes. But her three longest recesses on May 15 were only 22, 16, and 16 minutes; and the average of 10 recesses in rainless weather was only 14.6 minutes. Thus the rain had greatly increased the time she devoted to finding food, but did not increase her period of warming the eggs. This was doubtless because during a hard rain there are few insects upon the wing; and since she subsisted largely upon flying insects, she found it far more difficult to satisfy her hunger.

The male Redstart usually remained at a considerable distance from the nest. His song, when I could hear it at all, sounded from afar in the woods. Twice, however, he accompanied his mate as she returned to her eggs, calling, and singing *ch'ree ch'ree ch'ree ch'ree* in a clear, melodious voice. The female, after she had settled in the nest, answered him with a low murmur. After singing and catching insects for a few minutes in the vicinity of the nest, he flitted off among the trees, and his song grew faint in the distance. Even on these rare visits, he did not approach the nest closely.

Among the brightly colored species of North American wood warblers, the female is usually dull-colored and incubates the eggs without the assistance of the male. In many species of tropical warblers, male and female are equally brilliant in plumage, and I thought that perhaps they would prove to share the duties of the nest. But neither the male Pink-headed Warbler (*Ergaticus versicolor*), nor Hartlaub's Warbler (*Vermivora superciliosa*), nor the Orange-bellied Redstart, ever sat upon the nest. Later in Costa Rica, I found that the male Collared Redstart (*Myioborus torquatus*) and Buff-rumped Warbler (*Basileuterus fulvicauda*) likewise took no share in incubation. My experience with warblers has been duplicated with tanagers, finches, honeycreepers, orioles and other families. With few exceptions, all the members of the same family of birds follow the same general plan of incubating the eggs, and species in which the sexes are alike in color behave very much the same as species in which the sexes are greatly different. Contrary to the statements of theorists of the last century, the color of the plumage seems not to be correlated with incubation habits.

*The nestlings and their care.* Each day the female Redstart allowed me to come a little closer to her when I visited the nest, until finally I could bend down my head and look in at her from the distance of a foot, before she slipped out and fluttered away, "feigning injury." On May 22, this reaction was much stronger than ever before. Upon jumping from the nest at my near approach, she alighted on the ground only two yards away from me, relaxed and vibrated her wings, and moved as though in great distress. When I took a few steps toward her, she fluttered off ahead of me and alighted on the ground again to repeat the act. She did this a number of times, until I had followed her a good distance from the nest, when of a sudden she "recovered" and flew rapidly down the mountainside. Returning then to her nest, I found one little nestling, with red skin scarcely concealed by sparse gray down. It was remarkable how erect it stood—like a sentinel at his post—as it held up its widely gaping mouth for food. Then, exhausted by the momentary effort, it fell over and lay in the bottom of the nest. The occupants of the other two eggs were tapping at their shells; they hatched the following day, May 23.

The male Redstart, as we have seen, did not show much attention to his mate while she incubated; and while I watched, he never went to look into the nest. As a result, apparently, he had not become familiar with its position, and seemed to experience considerable difficulty in finding it when he first began to feed the nestlings. Just how he learned that they had hatched I do not know, for I did not replace my tent and again watch this nest until the nestling first to hatch was three days old, the other two a day younger. Even then the male seemed to waste much time in locating his children. He would come, singing, with his bill full

of insects, and fly to the wrong part of the bank. Here he would apparently search for the nest, returning again and again to look for it, seeming to be surprised at not finding it where it never had been. Sometimes he spent many minutes exploring various portions of the mossy sides of the depression before he at last came to the actual nest site. On three occasions he flew away, still carrying the food intended for the nestlings. Even after he had fed them several times in my presence, he seemed unsure of their exact location. During the three hours of my vigil that morning, his memory of the nest's position seemed to improve rapidly, until at last he went directly to it as his mate did. She fed the three nestlings 10 times, in the intervals of keeping them warm; but he gave them food only 5 times, and 3 times carried away the food he had brought.

The male Redstart was not at all afraid of my tent, for he flew all around it while searching for his nestlings; but it is possible that the sudden appearance of so large an object less than six feet from the nest confused him. The tent did not in the least disturb the female, although eight days had passed since she had last seen it.

One of the nestling Redstarts vanished when a few days old, and only two lived to leave the nest. They took their departure on June 2 and 3 respectively, at the age of about 11 days, when they were scarcely able to fly, and could only hop rapidly over the ground. Since I had removed them from the nest to examine their plumage, it is likely that they left somewhat prematurely. Their upper plumage, head, throat, and a portion of the breast were sooty gray. The lower part of the breast and the belly were buff, very different from the glowing color of their parents, and they lacked the chestnut crown.

By late July, before their parents have ceased to give them food, young Orange-bellied Redstarts have molted into a plumage difficult to distinguish from that of the adults. As soon as the young are able to take care of themselves, the families break up.

In the separation of male and female after the breeding season, the Pacific differs strikingly from the Costa Rican Orange-bellied Redstart and from the Collared Redstart. Although they sang far less than they had during the fine weather of April and May, the males sang occasionally on pleasant days through most of the rainy season, which extended from mid-May to mid-October. During this period, I heard their song far more often than that of any other wood warbler on the Sierra de Tecpán; but it was not so loud and clear as it had been during the nesting season. If two males happened to come together in the same mixed flock, they sang spiritedly against each other, and finally one would drive the other out of the flock.

#### COSTA RICAN ORANGE-BELLIED REDSTART

The Costa Rican Orange-bellied Redstart (*Myioborus miniatus aurantiacus*) is confined to Costa Rica, but closely similar forms are



widespread in the mountains of northern and western South America. It is found only at middle altitudes. Carriker (1910:800) gives its altitudinal range as 2,000 to 7,000 feet above sea-level, but it must be very rare at 2,000 feet, for on the Caribbean slope I have never met it below 3,000 feet, and seldom even at this altitude. On the Pacific slope, I have not encountered the bird below 3,700 feet.

*Appearance and habits.* In plumage and habits, this Redstart is the southern counterpart of the Pacific Orange-bellied Redstart. It has the same dark slate-colored upper plumage, wings and tail, the same chestnut crown and white outer tail feathers; but the breast and belly are cadmium yellow, instead of orange-red as in the northern bird.

In the vicinity of Vara Blanca, on the northern slope of the Cordillera Central of Costa Rica, I found these redstarts very numerous between 5,000 and 6,000 feet above sea-level. Here they dwelt in the humid, moss-draped cloud-forest, but they usually avoided its darker depths and were most often seen along its bushy edges, whence they ventured forth among the scattered trees and shrubs of the adjoining fields and pastures. Yet they rarely wandered far from the woodland and the heavier second-growth thickets. They remained mated through the year. The young birds appeared to find partners a few months after they were fledged; after October I nearly always saw these redstarts in pairs. In the eastern foothills of the Ecuadorean Andes, in August and September when they were apparently not nesting, I found the related race, *Myioborus miniatus pallidiventris*, living in pairs or alone.

The Costa Rican Orange-bellied Redstart hunts among the branches of the trees less than the Pacific; it forages far more frequently among the bushes along the margin of the forest, often quite near the ground, where it sometimes alights to pick up an insect. It rarely ascends to the tops of the higher trees. It has the same sprightly, active ways as the other redstarts, and catches much of its insect food upon the wing, making short sallies out from the bushes, frequently doubling and twisting through the air in an intricate course. It is, as a rule, somewhat less spectacular in its movements than the Pacific Orange-bellied Redstart or the American Redstart (*Setophaga ruticilla*), probably because it forages so much among low bushes, often in close, tangled vegetation, rather than in the more open crowns of trees. Sometimes, as it flits about in search of insects, it spreads its tail fanwise, displaying the white outer feathers in pretty contrast to the dark central tail feathers and upper plumage. Like the Pacific Orange-bellied Redstart, it sometimes searches over the bark of trees. One April morning at dawn, I watched a male ascend the clean, smooth trunk of a medium-sized tree, searching for insects as he went. He clung to the bark, then flitted up a short distance and clung again, repeating this until he reached the branches above. Here he flitted about, his wings drooping when not in use, his tail prettily spread, and sang his sweet, homely song.

The Redstarts' almost exclusively insect diet is from time to time varied with the little white protein bodies which they pluck from the brown hairy cushions at the bases of the long petioles of the great leaves of the cecropia trees. These ovoid corpuscles, the size of a mustard seed, are the chief food of the azteca ants that make their homes in the hollow stems and branches of the trees; but when the ants are absent, as is often true at higher altitudes in the subtropical zone, the corpuscles accumulate in numbers and are eaten by small birds—wintering warblers of several kinds, small finches, honey-creeper, and oven-birds, as well as redstarts.

*Song.* The song of the Orange-bellied Redstart of Costa Rica is simple; it is pleasant but neither strong nor ringing in tone: *chee chee chee chee chee chee*, the notes rising slightly in pitch toward the end. His notes are far less full and rich than those of the Pacific Orange-bellied, the Collared, or the Painted Redstart; his phrasing is less varied than that of the Collared Redstart and the American Redstart. But he does not restrict his singing to the season of courtship and nesting; he is heard in pleasant weather in every month of the year, although more rarely during the gloomy period from October to January. The call of this redstart is a weak *chip*.

*Nest building.* In 1938, I found the first nest of the Costa Rican Orange-bellied Redstart on March 30, when it was nearly completed. It was in a niche six feet above the base of a cut-bank eight feet high, beside a muddy mountain road along which many people passed. The little pocket in the clay wall was just big enough to contain the nest, and the site was further shielded from the elements by an overhang of root-bound earth at the top of the bank. Yet the nest, composed principally of straws, dry grass-blades and fibrous rootlets, was a roofed structure, with a round doorway in the side that faced out from the bank; and moreover, the roof had been made very thick. It may have served to shield the interior of the nest from falling particles of earth if not from the rain. The side walls were still thin, and one could see the earth of the bank through the right side of the nest. The floor of the nest, as is usual in such structures, had been left until the last; when I first looked in, the earthen bottom of the niche had not been covered over. It was to the covering and lining of the bottom that the builder devoted most attention while I watched on the morning of March 30.

Since the Redstart was too cautious to go to her nest while I stood in the roadway, in order to watch her at work I was obliged to screen myself within the border of high grass in the pasture below the road. Later, when she had become somewhat accustomed to her observer, I moved closer and stood behind a small cypress tree that had been planted beside the road. I watched for two hours, from 8:00 to 10:00 o'clock; during this period the female warbler brought material to the

nest 54 times. She picked up straws, grass blades, and other fine bits of vegetation from the road and the slope above the bank, and she sometimes tried to pull exposed slender rootlets from the bank, though usually without success. Later in the morning, when she had begun to line the nest, she brought, from the woods that began a short distance back from the top of the bank, bundles of fine brown fibers, of whose origin I remained in ignorance. She also visited a thick stump, overgrown with epiphytic bushes, ferns, and mosses, which stood at the edge of the road close beside me, vanishing into its cavities and fern-shaded recesses, to re-appear with her bill full of thread-like rootlets. She was usually cautious in approaching her nest, and perched upon some fallen brush beside the bank to look about her before she entered.

At this nest the male Redstart did not help with the work of building. Most of the time while his mate worked, he remained among the bushes on the slope above the nest, where he hunted insects and often sang. From time to time he came to perch upon a slender dead stem that projected from the bank a few feet from the nest. Here he sometimes sang but mostly rested in silence. At times he hovered in front of the nest to look in; and once, while his mate was within, arranging the material that she had brought, he came to stand upon the sill of the doorway. The female evidently did not approve of this visit, for she opened her bill in a threatening attitude.

On April 1, I found another nest being built in a very different sort of position. It was on the ground on a very steep slope in a bean-patch overgrown with low weeds, about 30 feet from the edge of the forest. It occupied a slight depression in the slope, and the sill of the entrance was just level with the ground in front. The fronds of a small fern, growing above the nest, bent prettily over the domed roof; it was screened in front by a seedling cecropia tree, and on the sides by tufts of grass. The slender trunk of a fallen tree, bridging the cavity in the hillside, stretched above the nest, helping to conceal and shelter it. The nest itself resembled the first that I found; it was entirely enclosed except for the round doorway in the side facing down the slope. The walls, roof, and cupped bottom were all quite thick; they were composed of soft, fibrous vegetable materials, with some decaying grass blades intermixed. The nest was nearly finished.

The male and female Redstarts were building this nest together. Since I could not distinguish them by appearance, and the male sang very little, and not at all while he worked, I was not able to determine the relative part taken by each sex in building. The two made no attempt to come and go together as tanagers of many kinds do; each went its way independently of the other. Yet despite this lack of coordination in their movements, on 10 occasions during the course of the hour and a half between 9:00 and 10:30 o'clock, I had proof that both birds worked at the nest, since I saw the second fly up to it with material in its bill, before the first, which had already added its contri-

bution to the structure, had left the clearing. Thus it was evident that both male and female took substantial parts in the labor of building. This was the first time that I had seen a male wood warbler of any kind help build a nest.

Among other things, the birds upon several occasions brought billfuls of the brown ramenta of a fern to their nest. I saw one of them pull the big, crowded scales from the bases of the great, thick, spine-studded petioles of the spreading fronds of a tall tree-fern that grew at the edge of the neighboring forest. While I watched these redstarts build their nest, I sat at the base of a tree on the slope above them, in plain view and at no great distance. At first, the birds, upon arriving with material in their bills, flitted about in the offing and hesitated to approach their nest, but soon they grew accustomed to my presence and went about their labors without fear.

The third nest at which I watched these Orange-bellied Redstarts work occupied a site quite different from those of the first two. A small fallen log, densely covered with slender aroids, ferns, mosses, and other epiphytic growths, lay in a pasture about 10 feet from the edge of the forest. The nest was built upon the log, and fitted snugly into a nook beneath the stems and roots of epiphytes; it was completely covered over by a thick layer of moss. The round entrance was screened by a bromeliad and the foliage of several small epiphytic shrubs. On the morning of April 5, after the cessation of the rain, I watched this nest from 9:15 to 10:15. It appeared to be finished, but the industrious builder continued to augment the already ample lining. During the course of the hour, she took material to the nest 15 times. Her mate flitted about in the vicinity, catching insects and often singing; but I saw nothing to suggest that he helped to build.

Two days earlier, I had watched yet another nest, whose builder, shier than most of her kind, would not go to her work in my presence. Here, too, I saw nothing to suggest that the male would have helped his mate to build. Quite a number of times I saw one of the pair flitting about with material in its bill, hesitating to approach the nest, but never two birds together with material. (When both members of a pair of birds build the nest, yet do not come to it together, sometimes the best way to prove that they both work is to delay their approach to the structure by standing near it and preventing the deposit of material until both have arrived with laden bills.) The following day, I spent a short while at a fourth nest, again without finding any evidence that the male helped to build. The male Redstart that took so large a share in the construction of the nest in the bean-field was evidently exceptional in his species, as he was among wood warblers in general. I wanted very much to see whether he would take an abnormal part in the subsequent duties of the nest, but unhappily it was prematurely destroyed.

The male Buff-rumped Warbler (*Basileuterus fulvicauda*) regularly takes a large share in building. I have seen a male do so at four nests.

But nest-construction by male wood warblers has only rarely been recorded; and aside from the single Costa Rican Orange-bellied Redstart and the Buff-rumped Warblers, I have never myself seen a male at work. It is possible that at the other redstart nests I watched, the male helped to build at other stages of construction, but I do not think this likely.

We have already called attention to a considerable variation in the Redstarts' nest sites: niches in cut-banks; a slight depression on a very steep slope, among sheltering vegetation; a fallen log amid low, dense epiphytic growth. But a cranny in a bank appeared to be the most favored location; 11 of the 14 nests I found in 1938 were so situated. The cottage that I occupied at Vara Blanca stood amid pastures which covered the back of a narrow ridge falling away steeply on three sides to wooded ravines or gorges. On the western side of the pasture, a foot-path followed along the side of the ridge for a distance of about a quarter of a mile. Along much of its length, this path had been cut into the steep slope, making a bank, in places three or four feet high, that faced the bushy border of the woods across the path and had the grassy hillside rising behind it. This low bank, in places covered by grasses creeping down from above, in others overgrown with ferns and small native herbs, was a favorite nesting site of the Orange-bellied Redstarts. In this one long bank, eight of their nests were built between the end of March and late May. Most were well-screened by surrounding vegetation. They were well-separated, although one was only 29 feet from an occupied nest of the Collared Redstart.

I did not have the good fortune to witness the very beginning of nest building in any instance, but from the examination of completed nests I learned something about the earliest stages of construction. After the selection of the nest site, the Redstart's first care was to carry into the cavity fairly large dead leaves to serve, apparently, as a foundation for the nest. These leaves included the foliage of dicotyledonous plants and bamboos, and fragments of the fronds of ferns. Some measured as much as six inches in length. Often a number were strewn in front of the nest site, whether intentionally or by accident I cannot say. From the ground in front of one of the nests, I picked up a double handful of dead leaves which obviously had not merely fallen from neighboring trees. I found a number of niches in banks, such as might have been selected by the Redstarts for their nests, which contained a small accumulation of dead leaves, mixed at times with some straws and the like, all of which appeared to have been quite recently placed there. Apparently the Redstarts had prepared to build in these crannies but afterwards abandoned them in favor of other sites that pleased them better. Some of the pockets that contained completed nests were lined all around with dry bamboo leaves; in others, this lining was confined to the sides and bottom. The Collared Redstart likewise builds its nest upon a foundation of broad dead leaves.

The nest beside the main trail, which I had watched as the bird built on March 30, was found lying in the roadway on the following day. On April 2, this bird had a half-finished nest only four inches from the site of her first. By the afternoon of April 3, the new structure appeared to be finished, after three (or at most four) days of work—only to meet the same fate as its predecessor. Another nest, found on April 2 when newly begun, appeared complete by April 5. A late nest was found in an early stage of construction on May 19 and seemed to be finished on May 23. Accordingly, these redstarts build their roofed nests in from three to five days.

*The eggs.* Despite the speed with which these rather bulky nests were constructed, about a week elapsed between the completion of the work and the laying of the first egg. This long period between the end of active building and the appearance of the first egg was noted at all seven of the early nests for which information is available. But a late nest (evidently a replacement), found under construction on May 19, was completed about May 23, and contained the first egg on May 25 (See Table 1).

The Orange-bellied Redstarts at Vara Blanca generally began to build their nests during the last days of March or the beginning of April. The earliest egg was found on April 7 (Nest 7). In nine nests, the first egg was laid during the week from April 7 to 13, inclusive. (Nest 10 is included in this number, from the calculated date of laying.) The three nests found with eggs in May were probably all replacements of earlier nests that had been lost. This close synchronization in the time of laying is surprising in a bird that dwells throughout the year in a region without marked seasonal variations in climate; yet it is paralleled, in my experience, in several other kinds of tropical birds. At Vara Blanca I kept only rough notes on the weather and took records of maximum and minimum temperatures with a Six's thermometer that was probably not very accurate. During the period of my residence there, July 1937 to August 1938, the only pronounced seasonal difference in weather was that the rain storms during the period from February to August were less protracted and severe than they had been during the preceding seven months. But during April, May, and June, when the great majority of the birds were nesting, there was much cloudiness and rain, and a dearth of sunshine.

The eggs were laid early in the morning—I have four records of eggs laid before 7:30 A.M.—and at intervals of one day. Eleven nests contained each three eggs or nestlings; two contained two eggs each. The eggs were white or dull white, speckled and blotched with brown ranging from bright brown to chocolate. The pigmentation was heaviest in a wreath at the point of greatest transverse diameter, or in a cap covering the larger end. The remaining surface was more lightly spotted

with the same color, the heaviness of the pigmentation varying considerably in different sets. Measurement of 20 eggs gave an average of 17.5 by 13.4 millimeters. The eggs showing the four extremes measured 18.3 by 13.9, 16.7 by 13.5 and 17.5 by 13.1 millimeters. Six eggs showed the minimum diameter of 13.1 millimeters.

Incubation apparently began with the laying of the last egg of the set. The fact that in all six nests for which information is available the eggs in a set all hatched within a period of approximately 24 hours, suggests that the Redstarts incubated little before their sets were complete. The nest that I most wanted to watch during the period of incubation—that which the male had helped to build—was prematurely destroyed; and the others seemed less important to study during this period than those of some other species of birds that then claimed my attention. It is almost certain that the female incubates without help from her mate, as in all other wood warblers for which I have information, including the related Pacific Orange-bellied Redstart and the Collared Redstart.

The incubation period varied from 13 to 15 days. Three eggs in one nest hatched 13 days after the set was completed and incubation presumably begun; three eggs in one nest hatched in fourteen days; nine eggs in four nests hatched in fifteen days. The eggs of the non-migratory Central American warblers seem generally to require a few days more incubation than those of the migratory species that breed in temperate North America. I have one record for the Collared Redstart: 15 days; one for the Pink-headed Warbler (*Ergaticus versicolor*): 16 days; seven records for the Buff-rumped Warbler: 16, 17 and (abnormally: one record) 19 days. The eggs of most North American warblers hatch after only 11 or 12 days of incubation.

*The nestlings.* The newly hatched Redstarts were pink-skinned and blind, and sparsely covered with down. At the age of 9 or 10 days, they were well-clothed with feathers, and after the age of 10 or 11 days, they were no longer brooded during the night. They left the nest when from 12 to 14 days of age. Six nestlings in three nests left at the age of 12 days; two in one nest, at the age of 14 days. I handled none of these nestlings after they began to be feathered, and the departures of all were probably spontaneous. At one nest (No. 11), however, I removed two nine-day-old nestlings for examination of their under plumage, which I could not otherwise see. As I lifted one from the nest, the other tried to jump out. When I had completed my notes on the plumage, I returned both young to the nest and induced them to remain there, at least until I was out of sight. But the following day the nest was empty. The nestling period of these young that had been handled was accordingly only 10 days, as compared with the 12 to 14 days of undisturbed young Redstarts.

*Reproductive success.* Tables 1 and 2 give the data for the 14 nests whose history is adequately known (including two replacements at the sites of earlier nests that had been despoiled). Of the 31 eggs laid, 10, or 32 per cent produced fledglings; of the 11 nests that contained these eggs, 5, or 45 per cent produced at least one fledgling. In my experience, this is about average success in reproduction among Central American birds—rather better than one would expect in the lowlands, not so good as might be found at still higher altitudes.

TABLE 1

SYNOPTIC HISTORY OF 14 NESTS OF COSTA RICAN ORANGE-BELLIED REDSTARTS  
Vara Blanca de Sarapiquí, Costa Rica, 5,300–5,600 feet  
March–June, 1938

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- Nest 1—Building March 30; destroyed by man, March 31.
- Nest 1a—Building 4 inches from Nest 1, April 2; apparently completed, April 3; destroyed by man, April 6.
- Nest 2—Building April 1; 3 eggs laid April 8, 9, and (presumably) 10; eggs broken and eaten, April 16.
- Nest 3—Begun about April 2; apparently completed April 5; 3 eggs laid April 12, 13, and 14; 3 nestlings April 28 (14 days incubation); all dead in nest May 4.
- Nest 3a—Found completed, resting on Nest 3, June 7; apparently never contained eggs.
- Nest 4—Nearly completed, April 4; 3 eggs laid April 12, 13, and 14; eggs broken and eaten, April 28.
- Nest 5—Nearly completed, April 4; 3 eggs laid April 12, 13, and 14; 3 nestlings, April 27 (13 days incubation); nestlings disappeared, May 4, 5.
- Nest 6—Apparently completed, April 2; 3 eggs laid April 8, 9, and 10; 2 nestlings, April 25 (15 days incubation); nestlings departed May 9 (14 days old).
- Nest 7—Found with 1 egg, April 7; second egg laid April 8; 2 nestlings, April 23 (15 days incubation); nestlings departed, May 5 (12 days old).
- Nest 8—Apparently completed, April 6; 3 eggs laid April 13, 14, and (presumably) 15; eggs disappeared, April 18.
- Nest 9—Apparently completed, April 7; 3 eggs laid April 13 to 15; 3 nestlings hatched April 30 (15 days incubation); nestlings departed May 12 (12 days old).
- Nest 10—Found with 3 nestlings a few days old, April 27. Subsequent history unknown.
- Nest 11—Found with 2 eggs, May 4; 2 nestlings hatched May 16; nestlings departed May 26 (10 days old—had been removed for examination).
- Nest 12—Found with 3 eggs, May 4; one nestling hatched May 13 (other 2 eggs infertile); nestling departed May 25 (12 days old).
- Nest 13—Found with 3 nestlings in pin-feathers, May 8; nestlings well feathered, May 16.
- Nest 14—Building May 19; nest completed, May 23; 3 eggs laid May 25, 26, and 27; 2 nestlings hatched June 11 (15 days incubation); nestlings disappeared June 18. (Near site of Nest 2 and probably belonged to same pair.)



TABLE 2  
REPRODUCTIVE SUCCESS OF THE COSTA RICAN ORANGE-BELLIED REDSTART \*

	Nest	Eggs				Nestlings	
		No. laid	De- stroyed	Not hatched	Hatched	Died or lost	Left nest
	1	0	—	—	—	—	—
	1a	0	—	—	—	—	—
	2	3	3	—	—	—	—
	3	3	0	0	3	3	0
	3a	0	—	—	—	—	—
	4	3	3	—	—	—	—
	5	3	0	0	3	3	0
	6	3	0	1	2	0	2
	7	2	0	0	2	0	2
	8	3	3	—	—	—	—
	9	3	0	0	3	0	3
	11	2	—	0	2	0	2
	12	3	0	2	1	0	1
	14	3	0	1	2	2	0
Totals		31 100%	9 29%	4 13%	18 58%	8 26%	10 32%
Totals by nests		11 100%	3 27%	3 27%	8 73%	3 27%	5 45%

\* Based on the nests listed in Table 1. Nests 10 and 13, whose history is unknown, are omitted.

*Absence of a second brood.* I continued field work in the same locality until the middle of August, but found no evidence of a second brood. The one nest whose dates suggest a second brood (No. 14) was near the site of an earlier nest from which the eggs had been lost. Wood warblers in general appear to raise only one brood in a year; in this, the species of the Central American highlands agree, so far as we know, with those that breed in the North. At lower altitudes in Costa Rica, the Buff-rumped Warbler breeds from March to August, a period long enough for two or even three broods; but I am not at all sure that the late nests are not merely repeated attempts at reproduction by birds which have earlier been unsuccessful in fledging their young.

*"Injury-feigning" or distraction display.* Sometimes, when interrupted while incubating their eggs or brooding their nestlings, these Costa Rican Orange-bellied Redstarts would "feign injury" in front of the nest. Since I passed almost every day, and often several times a day, along the path beside which most of these nests were situated, I enjoyed an excellent opportunity to witness these "distraction displays" and to learn something of the circumstances under which they took place. Other things being equal, whether or not a bird "feigns injury" often depends upon whether it finds a suitably clear area in which to perform; for although it has been claimed that birds are hysterical, or half-crazed, or otherwise not in full control of their faculties when they behave in this manner, they are usually sufficiently in possession of their wits not to beat their wings and flap about amid dense vegetation where there is danger of their becoming entangled and falling an easy prey to their enemies. Since all of these redstarts had, in the clear pathway in front of their nests, a suitable stage upon which to act, variations in behavior might be attributed to individual differences among the birds rather than to the varying nature of the surrounding area.

Of the eight Orange-bellied Redstarts that nested in the bank beside the path, three were never seen to make any special display upon leaving the nest. Two of these successfully reared fledglings, but the third lost her eggs when they were on the point of hatching. The remaining five varied considerably as to the stage of the nesting at which they displayed. The female of Nest 6 feigned injury soon after she began to incubate, but not thereafter, although she successfully reared her nestlings. The owner of Nest 8 gave an excellent performance the day after she began to incubate. (Two days later she lost her eggs.) The Redstart of Nest 11 displayed nine days before her eggs hatched. At Nest 7, the female feigned injury only on the day her eggs hatched. At Nest 3, the performance was witnessed three days before hatching, on the day the eggs hatched, and when the nestlings were two days old. Even in a single day, the same bird did not consistently feign injury when driven from the nest. Possibly this depended upon how long she had been sitting before she was interrupted. (See Pickwell, in Bent 1942:349.)

Usually the Redstarts sat bravely, permitting me to approach very close to them before they left the nest. Some would allow me almost to touch them; others would sit steadfast and return my gaze with eyes only a hand's breadth from my own. But a closer approach would cause them to dart past me and fly toward the neighboring woods. There was no relationship between the closeness of the bird's sitting and her display upon leaving; some of the Redstarts that would allow me to come within a few inches of touching them never displayed. Those birds that attempted to lure me from the nest by the "distraction display" usually dropped from their nests into the pathway almost at my feet, where they vibrated their relaxed wings and moved slowly, as though in-

jured, toward the bushes on the farther side. Others would flit directly from the nest to the vegetation at the edge of the neighboring forest, where they raised and fluttered their wings, depressed their tail, and hopped mincingly from stem to stem, always keeping near the ground. Sometimes, after passing from view among the foliage, they would return to the edge and continue to perform where they caught my eye. Such behavior certainly seemed purposive, and not merely a substitute reaction.

*The fledglings.* When they left the nest, the young Redstarts wore a plumage very much duller than that of the adults. The head was dingy black, with no chestnut on the crown. The upper plumage, throat, and chest were dark slate-color. The lower breast and belly were buff. The outer tail feathers were white, as in the adults. This body plumage was worn only for a brief period; soon after beginning to fly, the young birds started to acquire the colors of the adults. The last remaining mark of immaturity was the dull black crown; but by mid-July, some individuals had chestnut feathers on their heads. Soon there was little difference between the adults and the young of the year. By October the young birds, now indistinguishable from the adults, appeared to have mated; for most redstarts of this subspecies were then in pairs.

#### COLLARED REDSTART

The charming Collared Redstart (*Myioborus torquatus*) is confined to the mossy, humid forests of the southern highlands of Central America—in Costa Rica and western Panamá. It is the biggest and to my mind the prettiest of the Central American members of this attractive genus. Its upper plumage is black or blackish, and it has the chestnut crown-patch characteristic of the group. Its forehead, face, throat, and all the under parts are bright yellow, with a black band or collar extending across the breast, joining the black of the upper plumage. Its long tail is black, with snowy white outer feathers. Its bill and eyes are black. The sexes are alike.

*Habits.* Carriker (1910:799) states that in Costa Rica the Collared Redstart ranges from about 3,500 feet above sea-level up to timberline on the high volcanoes. Hence it extends considerably higher than the Orange-bellied Redstart of Costa Rica, although their two ranges overlap over a wide area. I found it very abundant on the storm-beaten northern slopes of the Cordillera Central between 5,000 and 8,000 feet above sea-level. Although essentially a sylvan bird, it frequents the bushy woodland edges, and such openings as are made by roadways or the fall of some giant tree, rather than the dark depths of the unbroken mountain forest. Sprightly, graceful, and restlessly active, it hunts its insect food at all levels from the tree-tops to the ground, yet is most often seen at middle heights. It searches over the bark of trees far more seldom than the two forms of Orange-bellied Redstart described

above, but like them, it frequently catches insects on the wing. Sometimes, in the lower parts of their altitudinal range, Collared Redstarts in pairs will be found following the army ants in company with a variety of other small woodland birds. They concentrate chiefly upon the capture of such winged fugitives from the ant horde as they can snatch in the air; and their bright colors and active habits make them the most conspicuous figures in all the motley flock.

Unlike the American Redstart, Painted Redstart, and Pacific Orange-bellied Redstart, the Collared Redstart rarely lives alone during the winter months. After the separation of the young birds from their parents, which usually occurs in August or September, Collared Redstarts are most often seen in pairs. Yet even in November and December, it is not rare to find from three to five birds together.

In the wilder portions of the Costa Rican highlands, most birds are as fearless of the human presence as one will find them anywhere save on uninhabited oceanic islands. But the Collared Redstart is the most friendly of all. Sometimes, while I watched them, one of these warblers would alight on a branch so close in front of me that I might have reached out and touched it. One afternoon, while I squatted beside a wren's nest in a bushy opening in the forest, I was surrounded by a family of Collared Redstarts, consisting of parents and young already in the adult dress. Of a sudden, one of the young birds flew up to me and stood on the crown of my hat where, possibly, it had espied an insect. I remained motionless, and it lingered upon my head for several seconds, then flitted off again. At their nests, too, I found the Collared Redstarts almost fearless of me. Because of its trustful ways, the Costa Rican mountaineers sometimes call this bird *el amigo del hombre*, the friend of man.

*Song.* Not only is the Collared Redstart the brightest in plumage of the three forms of *Myioborus* discussed here, it is also the most gifted singer. Its delightful song is long-continued, full and mellow in tone, varied in phrasing, and easily distinguished from the simpler music of the other redstarts that I have heard. It is both longer and more powerful than the simple notes of the Orange-bellied Redstart of Costa Rica. It is far longer and more varied than the songs of the Pacific Orange-bellied and the Painted Redstarts; although it perhaps equals the former in richness of tone, it falls somewhat short—if memory is to be trusted—of the latter's strong full voice. The Collared Redstart is a notable songster among all the wood warblers. During my year at Vara Blanca, I heard it very rarely from July to February; during this period it sang far less than its neighbor, the Orange-bellied Redstart. But in March, as the breeding season approached, it entered its period of full song and was a joy to hear.

The call note of the Collared Redstart is a sharp monosyllable, *pit*, similar to the *chip* of the Orange-bellied Redstart, but distinctly sharper.

*Nest building.* At Vara Blanca, on the northern slope of the Cordillera Central of Costa Rica, the Collared Redstarts, although by no means rare between 5,000 and 6,000 feet above sea-level, were far less abundant than the Orange-bellied Redstarts. In 1938, I found 14 nests of the Orange-bellied but only two completed nests of the Collared. Since the two species placed their nests in similar situations, and these were accordingly equally easy to find, the number of nests discovered is probably a good index of the relative abundance in the study area of the two kinds of redstarts.

The first Collared Redstart's nest was found on April 3 when already nearly completed. It was situated in a deep recess in a vertical cut-bank beside a little-used pathway. Above the bank was a pasture with scattered trees and clumps of low, spiny palms; below the path was forest, with tangled undergrowth, falling away into a ravine. The bank was 4 feet high; the niche which sheltered the nest, 40 inches above its foot. The nest was a roofed structure with a round entrance in the side facing out from the bank. It resembled the nests of the other Central American forms of *Myioborus*, but had a thinner roof. The foundation was composed of dry bamboo leaves, others of which lay loosely in front of the doorway. The chief material of the structure was fine vegetable fibers, which in the floor and lower part of the walls were matted together to form a thick, soft fabric. The liverworts, mosses, and low herbage on the walls and about the entrance of the niche in the bank quite screened the nest from the casual glance. Two feet distant, in a more shallow cranny in this bank, was an old nest of the same kind, possibly the preceding year's nest of the same pair. Twenty-nine feet to the north, a Costa Rican Orange-bellied Redstart was building her nest in the same bank.

I sat without concealment in the path north of the Orange-bellied Redstart's nest, hoping to watch both kinds of warbler build at the same time. The Collared Redstart, whose nest was 70 feet away, went ahead with her work as though I were not there; but the Orange-bellied Redstart, whose nest was only 40 feet distant from me, feared to approach it. I made trial of various positions, and learned that the Collared Redstart was not afraid of me even when I sat within 14 feet of her nest; but the Orange-bellied Redstart continued to be shy when I was 15 yards from hers. This agreed with my earlier experience that the Orange-bellied Redstart is consistently less confiding than the Collared Redstart. Since I could find no position that gave a satisfactory view of both nests, and yet did not disturb the more wary bird, I sat with my back to the Orange-bellied Redstart and gave my attention wholly to her trustful neighbor.

At 8:00 o'clock, when I began to watch the Collared Redstart at her building, a fine drizzle was falling from the clouds that swept low above the open pasture and drifted through the tops of the trees in the neighboring forest, whence fell larger drops of moisture that had condensed

on the foliage. From time to time the precipitation increased to the intensity of a light shower; and by 9:45, the rain had become hard enough to drive me to shelter. Yet despite the unfavorable weather, the Redstart kept steadily at her work. During the 105 minutes of my watch, she brought 34 billfuls of material to her nest. She found all of this material in the woods down the slope, and would arrive at the bushy edge of the woodland with her bill laden with an ample bundle of fine, light-colored bast fibers, or the brown ramenta from a fern frond. Then, after a moment's pause, she would flit across the path and come to rest on the top of the bank near her nest. Here she delayed a few seconds more, then flew out and hovered, facing the bank, and finally darted into the nest. In the deep niche she was invisible to me while she worked. Upon emerging, she sometimes rested a few moments on top of the bank; but at other times she flew directly down into the woods.

The male Redstart often followed his mate on her trips to and from the nest. Sometimes he waited at the edge of the woods while she went into the niche, but frequently he crossed the path and rested on the herbage at the top of the bank while she arranged the material. Occasionally he sang here; but more often I heard his beautiful song coming out of the woods, where I could not see him. He never brought any material to the nest.

Although I watched from a point only five yards from the nest, while sitting in the pathway without the slightest concealment, the Collared Redstarts appeared to be perfectly indifferent to my presence. When I was ready to go, I rose and stood in the path only seven feet from the nest, directly in front of it. While I waited in this position, the female arrived at the edge of the woods with her bill full of the big, brown ramenta of a fern, almost the color of her crown. After a little hesitation, she flew into the nest to deposit her burden.

I found two other nests of the Collared Redstart during April in the neighboring pasture. The first was newly begun when discovered, on April 6, in the midst of the odorous calinguero grass (*Melinis minutiflora*) on a steep slope. The bird had chosen as her nest-site a little hollow in the hillside, beside a large clod of earth, and beneath the overhanging stems of the grass growing higher up the slope. Her first step in building was to lay as a foundation a number of dry bamboo leaves, which she carried up from the edge of the woods about a hundred feet down the hillside. This nest was still not quite completed by April 18, and four days later I found it partially destroyed.

On April 24, I found another Collared Redstart building a nest beneath a decaying log, amid fallen brush in the pasture, also about a hundred feet from the edge of the forest. This nest was placed upon the sunken remains of another of the same kind, which raised it a few inches above the earth. A number of dead leaves of dicotyledonous plants, brought by the Redstart, littered the ground in front of the nest. As

with the Orange-bellied Redstart, the first step in building appears to be the collection of broad, dry leaves, and many are dropped a few inches short of the nest-site. This nest appeared to be completed by April 26, contained one egg on April 30, and two—the full set—on May 1. On May 8, I found that the nest had been torn from its nook beneath the log, and the eggs had vanished. An examination of the ruins revealed that the structure had been composed of fine, light-colored bast fibers; shreds of plant epidermis; long, black fibrous roots; and large, brown ramenta of tree-ferns—all in considerable quantities. Since these two nests were prematurely destroyed, we must depend for our study of the later stages of nesting on the first, in the bank beside the path at the edge of the woods.

*The eggs.* On April 4, the day after I watched in the rain while she carried material into the deep recess in the bank, the female Redstart continued to add to the lining of her nest, but it appeared to be practically completed. Still, the first egg was not laid until April 10; two more were laid on the succeeding days. The three eggs were white, sprinkled all over with light brown; but the dots of color were most concentrated in a wreath about the large end. The eggs measured 19.1 by 13.5, 19.1 by 13.5 and 18.7 by 13.5 millimeters. The eggs in another set found later were similar in coloration but somewhat shorter, both measuring 18.3 by 13.5 millimeters.

*Incubation.* The female Redstart began to incubate on April 12, the day her set of three eggs was completed. She was already much attached to her nest and would not fly out when I stood directly in front of it. Four days later she sat so closely that I might have caught her in the niche had I cared to do so. She would allow me to look in at her with my face only a few inches from the front of the recess in the bank.

Despite the Redstart's great fearlessness, to study her mode of incubation I decided to watch from a blind; for I wished to feel quite certain that the pair would be in no wise constrained by my presence. Seated in my brown wigwam placed in the pathway a short distance from the nest, I made a continuous record of events there from 5:30 to 10:50 on the morning of April 23, 11 days after incubation had begun. The female alone incubated the eggs, and she was extraordinarily regular in her comings and goings. The eight sessions in the nest which I timed varied only from 27 to 30 minutes, with an average of 28.5 minutes. The eight recesses from incubation ranged from 7 to 13 minutes, with an average of 9.8. The Redstart sat always sideways in the nest, usually with her left side outward. Her long tail projected through the doorway at one side, while her head was turned to look out through the opposite extremity of the opening.

While I watched, the male did not once come near the nest, nor even show himself in the pathway. From time to time, but not very often, I

heard his song coming out of the forest down the slope. I only once saw him accompany the female as she returned to the nest, and then only as far as the edge of the woods.

On the morning of April 24, the female Redstart sat, as was her custom, until I put my hand to the entrance of the niche. Then she slipped past it, fell to the ground at my feet, slightly lifted the tips of her wings and waved them as though helpless. She crept over the ground to the edge of the woods, still quivering her wings, then hopped slowly about, low among the bushes, continuing to vibrate her uplifted wings. This was the first time that she had used the distraction display in my presence—12 days after she had begun to incubate. On the next two days she behaved in the same fashion when I made her leave the nest because I wanted to see whether the eggs had hatched. The eggs were pipped on April 26, and hatched the following day. The female Redstart again gave an excellent "injury-feigning" display on April 30; but after that I saw no further repetition of the performance. Her use of this display was restricted to the period extending from three days before to three days after the eggs hatched.

The three eggs hatched on April 27. Since the last had been laid, and incubation begun, on April 12, the incubation period was 15 days.

*The young.* The nestling Redstarts had the pink skin and sparse natal down of other newly hatched wood warblers. On April 30, I found one of the three-day-old nestlings lying dead in the niche a few inches in front of the nest. It appeared to be well fed and probably had been accidentally brushed out of the nest by its mother as she departed—a mishap by no means rare among small birds. By May 7, when 10 days old, the two surviving Redstarts were well feathered. They were brooded by their mother on the night of May 6, and again on the night of May 8, but for some unexplained reason not on the night of May 7. On May 10, the two surviving nestlings left their protected niche in the bank, at the age of 13 days. I had not touched them after they began to grow feathers, and I believe that their departure was spontaneous. They bore little resemblance to their parents, for their entire upper plumage, head, throat, and breast were dark slate-color, with no trace of chestnut on the crown, and no yellow on the forehead, face, or throat. But this juvenal plumage was worn for a very short while. By the end of May, young birds of the year were beginning to acquire the adult colors. (Since I had seen no indication of nesting until late March, it is unlikely that these birds had been hatched before the middle of April, at the earliest.) In the first stages of the postjuvenal molt, the forehead, lores, lower cheeks, and throat were pale yellow, flecked with gray, over an area of irregular outline. There was a broad gray band across the chest; the lower breast and belly were yellow—brightest on the flanks, fading to whitish in the center of the



abdomen. These changes were evident before chestnut feathers were visible upon the crown. The wings and tail resembled those of adults. By the middle of June, before they parted company with their parents, the young birds were difficult to distinguish from their elders. Since by August most of the Collared Redstarts were in pairs, it seems likely that the young of the year found mates very soon after becoming independent.

#### SUMMARY

Three forms of *Myioborus* were studied in Central America, the Pacific Orange-bellied Redstart (*M. miniatus hellmayri*) in Guatemala, 1933; the Costa Rican Orange-bellied Redstart (*M. miniatus aurantiacus*) and the Collared Redstart (*M. torquatus*) in Costa Rica, 1937-38.

The Pacific Orange-bellied Redstart ranged from 2,000 to 9,500 feet above sea-level, but was particularly abundant in heavy, humid forests on the Pacific slope between 5,000 and 7,000 feet.

It frequently forages in the higher branches of the trees.

Outside the breeding season, the Pacific Orange-bellied Redstart avoids other redstarts of its species but attaches itself to the large mixed flocks of small birds that roam through the forest, in each of which there is usually a single Orange-bellied Redstart. If two males come together in the same mixed flock, one drives the other from the flock.

A nest with three eggs was found on May 13, 1933.

The female alone incubated, and the male did not even approach the nest during the incubation period.

In 12 hours of observation, 11 sessions on the eggs ranged from 26 to 49 minutes, with an average of 37.6 minutes; 12 recesses from incubation ranged from 10 to 37 minutes, with an average of 18.2 minutes. Of the total observation time, 67.4 per cent was devoted to incubation. In rainy weather, recesses were longer than in clear weather, but sessions on the eggs showed no significant change.

One nestling was hatched on May 22, two on May 23. They were sparsely covered with gray down.

During 3 hours of observation when the young were 2 and 3 days old, the female fed the nestlings 10 times in the intervals of brooding; the male fed them 5 times.

One nestling disappeared when a few days old. The other two left the nest on June 2 and 3, at about 11 days old (perhaps prematurely because of disturbance).

Their upper plumage, head, throat, and a portion of their breast were sooty gray; the lower part of the breast, and the belly were buff.

By late July, the young molt into a plumage very similar to that of the adults.

As soon as the young can take care of themselves, the families separate.

The Costa Rican Orange-bellied Redstart is found at middle altitudes; it is rare below 3,000 feet, abundant between 5,000 and 6,000 feet.

It forages chiefly in bushes near the ground.

The male sings in pleasant weather in every month of the year.

This redstart occurs in pairs throughout the year, the young finding partners a few months after they are fledged.

Fourteen nests were found. Nest building began during the last days of March or in early April. The nests were constructed in from 3 to 5 days. Nest sites varied: niches in a cut-bank (the favored location); hidden at the base of epiphytes on a fallen log; a slight depression in a steep slope among sheltering vegetation.

At one nest the male assisted in nest construction.

There was an average interval of a week between completion of the nest and the beginning of egg laying.

Two to three eggs were laid at one-day intervals. In 9 nests, the first egg was laid between April 7 and 13. In 3 nests (probably replacements of earlier nests), it was laid in May.

Incubation began with the laying of the last egg of the set. The incubation period varied from 13 to 15 days. All the eggs of a clutch hatched within a period of about 24 hours.

The newly hatched young were blind and sparsely covered with down. At the age of 9 or 10 days they were well-clothed with feathers, and were not brooded after the age of 10 or 11 days. They left the nest when from 12 to 14 days of age.

Of the 31 eggs laid, 10 (32 per cent) produced fledglings. Of the 11 nests that contained the 31 eggs, 5 (45 per cent) each produced at least one fledgling.

On leaving the nest, the young wore a plumage very much duller than that of the adults. By October they were indistinguishable from the adults.

The Collared Redstart ranges from 3,500 feet up to timberline and is fairly abundant between 5,000 and 8,000 feet. It is far less abundant than the Costa Rican Orange-bellied Redstart.

It forages at all levels but is most often seen at middle heights.

The species is usually seen in pairs or in groups of three to five.

A nearly completed nest was found on April 3. The male did not assist in nest building but remained in the vicinity, often accompanying the female on her trips for nest material. A second nest, newly begun on April 6, was not yet completed on April 18. A third nest, found on April 24, appeared to be completed on April 26 and contained one egg on April 30.

The first egg of a 3-egg set was laid on April 10 (6 days after the nest was apparently completed). The eggs were laid at one-day intervals.

Incubation began the day the last egg was laid. The female alone incubated. In 5 hours and 20 minutes of observation 11 days after incubation had begun, 8 sessions on the eggs varied from 27 to 30 minutes (average, 28.5 minutes); 8 recesses from incubation ranged from 7 to 13 minutes (average, 9.8 minutes). The incubation period was 15 days.

One nestling was found dead outside of the nest. The remaining nestlings were well feathered when 10 days old and left the nest when 13 days old.

By the end of May young Collared Redstarts begin to acquire the adult colors.

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