

A STUDY OF THE RUFIOUS-FRONTED THORNBIRD AND ASSOCIATED BIRDS

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HANGING from isolated trees in northern Venezuela are compact masses of interlaced twigs so large and conspicuous that they can hardly escape the attention even of the traveler speeding along the excellent highways of that country. From a Venezuelan companion he may learn that the oblong masses of sticks are nests of the *guaití*; but without patient watching he is not likely to see the retiring, wren-like builder of these incongruously large structures. The *guaití* bears the English book-name of Rufous-fronted Thornbird (*Phacellodomus rufifrons*) and is a member of a large Neotropical family, the Furnariidae or ovenbirds, second to no other avian family in the world in the diversity of its nidification. The brief accounts that I had read of this remarkable bird, suggesting unusual social habits, whetted my desire to learn more about it.

A grant from the Frank M. Chapman Memorial Fund of the American Museum of Natural History provided financial support for an extended visit to Venezuela. Correspondence with Paul Schwartz gave hope that we could find a suitable place to live while studying thornbirds. He met us at Maiquetía Airport soon after midnight on 12 March 1966 and, after showing us over the Parque Nacional "Henri Pittier" (Rancho Grande), took us to "La Araguata." This large cattle farm, belonging to the bird artist Walter Arp and his wife Elena, is situated, at an elevation around 1,400 feet, in a basin among low mountains near Pirapira, about 20 miles south of Valencia in the state of Carabobo. For over four months the Arps, then living in Valencia, gave us the use of their comfortable farmhouse and with unforgettable kindness forwarded our endeavor in innumerable ways. My wife Pamela kept house and helped with the observations on thornbirds. To all those who in these various ways contributed to the success of our visit to Venezuela, I am most grateful.

PART I. LIFE HISTORY OF THE RUFIOUS-FRONTED THORNBIRD

THE BIRD AND ITS HABITAT

The Venezuelan race of the Rufous-fronted Thornbird (*Phacellodomus rufifrons inornatus*) is a rather long-tailed bird about six inches in length, with no noticeable differences between the sexes. Its dorsal plumage is brownish olive, slightly rufescent on the rump, upper tail coverts, and the exposed bases of the remiges. The stiff, lanceolate feathers of the forehead and fore part of the crown give these regions a streaked aspect. The rufous on the forehead is not conspicuous and may escape casual observation. There is an indistinct light superciliary line set off by a faint dark postocular streak. The chin and throat are whitish, becoming grayer hindward and

merging into pale cinnamon-buff on the lower abdomen, flanks, and under tail coverts. The upper mandible of the slender bill is dusky, the lower is gray, and the interior of the mouth is black or nearly so. The legs and toes are grayish. The iris of a breeding thornbird will at one angle appear yellowish brown or gray, at another, as the bird turns its head, pale blue.

The species *P. rufifrons* is widely distributed over the more arid and open parts of South America, east of the Andes, from the Caribbean coast to northern Argentina. The race *inornatus* is widespread in Venezuela north and west of the Orinoco, not only in the mountainous northern part of the country but in the flat *llanos* to the south. It is primarily a bird of the warm lowlands; the highest point at which I noticed it was in the botanic garden at Caracas, at about 3,000 feet above sea level, where its nests were conspicuous. It appears to be permanently resident wherever it is found; established pairs probably never wander more than a few hundred yards from the nest which is their center of interest and their dormitory at all seasons. These nests often hang prominently near human dwellings; for the thornbirds, lacking bright plumage and elaborate song, escape the persecution which afflicts their more brilliant avian neighbors and accordingly are more trustful of man. I never found it necessary to conceal myself while studying them.

Thornbirds are ground-foragers that prefer low, dense thickets and weedy fields, with here and there a large or small isolated tree to support their nests. They avoid heavy forest and even light woodland with a closed canopy. At Pirapira, where the dry season is long and severe, I failed to find them in the second-growth woods with crowded slender saplings but sparse ground cover that occupied large areas of abandoned farmlands on the lower slopes of the hills. They were likewise absent from the stony upper slopes of these hills, where low, thick-barked, gnarled trees and a few fire-resistant shrubs grew scattered amid bunch grass that was often swept by fire in the dry season. During a day spent on the *llanos* in the state of Cojedes, we did not notice any thornbirds' nests on trees that stood in the midst of extensive areas of grassland; but these structures were abundant in or near open stands of trees with bushy undergrowth. The tree chosen for the nest may, indeed, grow 100 feet or more from the nearest thicket, in the midst of a bare cultivated field or a pasture of tall or short grass, across which the birds fly rapidly when approaching or leaving their abode. In intensively cultivated districts, thornbirds are found chiefly along bushy roadsides and fence rows, and about farmhouses surrounded by shade trees and shrubbery. (Fig. 1).

Wherever they occur, thornbirds travel through the dense, concealing vegetation in family groups which probably rarely exceed seven or eight



FIG. 1. View at "La Araguata." Rufous-fronted Thornbirds foraged in the thickets bordering the extensive pastures and nested in trees amid these pastures. In the line of trees to the left of the roadway was a nest in which six thornbirds slept. July 1966.

individuals; but they are so secretive that to count them accurately one must watch as they retire into their nests at nightfall or emerge at dawn. They are sociable birds who do not hold their companions aloof. Although I did not see one preen another, I watched one come close to another that was arranging its feathers and lightly touch the other bird's plumage with its bill. To scratch their heads, thornbirds raise a foot over and within the relaxed wing on the same side of the body, which is the usual method in passerine birds.

FOOD AND FORAGING

To learn what thornbirds eat, I watched them forage and noticed what they brought to their nestlings. Since it was difficult to keep them in view for long as they hunted through thickets hardly penetrable by man, the second method yielded more information. As with the other members of the ovenbird family with which I am familiar, thornbirds take little or no vegetable food. They subsist chiefly upon small or middle-sized insects in

the larval, pupal, and mature stages. Spiders are sometimes captured. Rarely I saw a parent carrying a small round object which may have been a berry but was more probably some kind of egg case.

Thornbirds forage chiefly on the ground, beneath bushes and weeds. In the dry season, when fallen leaves cover the soil, they spend much time searching beneath the litter, often pushing their foreparts beneath it, sometimes even disappearing under a loose accumulation of dry leaves, to emerge on the other side. I never saw them throw or push fallen leaves aside, as many other ground-foragers do; their habit of creeping beneath the litter makes this effort superfluous. Sometimes the thornbirds ascend higher to investigate masses of dead leaves that have lodged in bushes and vine-tangles, occasionally pulling out a leaf and dropping it. Although not averse to rising to the crowns of small or even large trees, where they often build their nests, thornbirds rarely forage far above the ground. While searching for food they utter low, slight, sharp notes and from time to time burst into loud song. At "La Araguata" they sometimes hunted with Pale-breasted Spinetails (*Synallaxis albescens*) and Buff-breasted Wrens (*Thryothorus leucotis*), whose foraging habits are rather similar.

A pair of thornbirds feeding nestlings close by the house at "La Araguata" often hunted in a pile of rotting leaves that had been raked up from the garden, and in heaps of brush, into which they vanished. They hopped over a small patch of ground where the weeds had been chopped close, leaving the area bare and brown, and they searched the exposed bases of some banana plants growing there. One of the thornbirds climbed up through a skein of drying vines that draped a tree trunk, disappearing into the tangle. Sometimes they hunted on the bank of the neighboring brook. Their methods of foraging differed little from those of a Southern House Wren (*Troglodytes musculus*) also hunting food for nestlings in the same area at the same time, except that the wren often walked over the ground with alternately advancing feet, while the thornbirds always hopped with their feet together.

VOICE

Thornbirds are seldom long silent, and their frequent outbursts of loud, ringing song, no less than their spells of quieter twittering, suggest a cheerful, contented nature. Their varied utterances fall into three main classes, which may be briefly characterized as: (1) singing or calling, (2) twittering, and (3) chipping.

The song is a series of rapidly repeated, similar notes that always sounds bright and joyous and at its best is beautiful. This is especially true when the loud, rather sharp notes with which the series begins are followed by somewhat lower, mellower notes. It then reminds me of the song of the Scaly-

throated Leaf-tosser (*Sclerurus guatemalensis*), one of the best songsters among the ovenbirds, but it is not quite so lovely. Loudest of the thornbird's utterances, the song also serves as a call, to communicate with a distant mate. When singing at fullest intensity, the thornbird stretches its body upward until it is almost vertical, with the head tilted skyward until, at times, the bill points straight up, while the downwardly directed tail beats time to the notes. At lower intensity, the song is delivered from a more normal posture. Variations in the song are chiefly in loudness and length, as, in common with other tracheophones, the thornbirds lack a diversified repertoire.

Mated thornbirds often duet, especially while building or attending their nests. Perching side by side or facing each other on their hanging mass of sticks, they lift up their heads and pour out their bright notes in unison. There is little difference between the songs of the two sexes; but in some pairs it has seemed to me that one, doubtless the male, had the stronger voice. Yet variations in the loudness of the songs of each individual tend to mask sexual differences, if indeed they occur. The thornbirds often sing not only on their nests but also within them, especially in the dim light of dawn before they emerge in the morning, or after they retire in the evening, or even while incubating or brooding. The song of one family often stimulates the members of a neighboring family to raise their voices. Loud singing accompanies territorial disputes.

Twittering consists of a rapid, continuous flow of low weak notes, which are sometimes squeaky. Occasionally the twitter is punctuated by little *peep*'s. It is often heard issuing from a nest into which several birds have just retired for the night, and again while they rest inside, doubtless huddled together, before sallying forth at dawn. At such times it may continue, with brief intermissions, for minutes together. Thornbirds also twitter much while building and attending their eggs or young. A duet by a mated pair may be followed by twittering. Thornbirds twitter while close to each other rather than alone, seeming thereby to express contentment or mild, pleasant excitement.

The third class of the thornbirds' utterances consists of monosyllables which, according to circumstances, vary from slight *tick*'s to loud, sharp *chip*'s. These notes are strongest and most penetrating when an actual or potential enemy, such as a snake, a cat, or a man, approaches a nest containing eggs or young or parents foraging with fledglings. In such situations they undoubtedly express alarm or anxiety. As one watches a nest in the evening, slight *tick*'s issuing from the neighboring thicket often announce that a thornbird is about to fly up to its dormitory. Here, too, the bird may feel some degree of anxiety as it prepares to leave the dense protecting

vegetation for a flight through the open air, exposed to the attack of raptorial birds, on its way to its high nest. Sounds of much the same character are commonly heard from thornbirds foraging over the ground, and in this case they appear to be primarily location notes that serve to keep the flock together.

In each of these three classes of utterances—song, twittering, and chipping—there are endless variations in intensity, tone, and tempo; but they are too difficult to describe, and their meaning too obscure, for profitable discussion.

TERRITORY

Despite their sociability, thornbirds are territorial and resist the intrusion of members of other families. I made no attempt to trace the limits of territories, which at "La Araguata" traversed impenetrable thickets, chiefly on the more steeply sloping land between the extensive pastures; but on several occasions my attention was drawn by what appeared to be territorial disputes. On the morning of 22 May, attracted by loud singing, I found half a dozen or more thornbirds in the undergrowth of a patch of light woods, about midway between two nests each occupied by six grown birds. They were flitting about excitedly, and sometimes one bird mildly chased another. Once two confronted each other momentarily, but they did not clinch together. Soon the birds drifted apart.

Twice, while I watched the thornbirds attend their eggs at nest 8, in which only the mated pair slept, the incubating bird suddenly left the nest to drive away a third thornbird who had appeared in the vicinity. On the first occasion there was much singing and some chasing; and after the trespasser had vanished, the resident pair were most vociferous, singing and twittering together. On the second occasion, the intruder came so silently that I was unaware of its approach until the incubating bird emerged from the nest to drive it away. How did the bird inside the nest sense the arrival of the other, whom it could hardly see? After chasing away the intruder, the resident bird perched in the top of a small tree near its nest and rapidly repeated sharp *chip*'s before it returned to its eggs.

This pair of thornbirds ignored the presence of a pair of Vermilion-crowned Flycatchers (*Myiozetetes similis*) busily feeding nestlings in a domed nest close by their own. Another incubating pair of thornbirds did not chase a Red-crowned Woodpecker (*Centurus rubricapillus*) who foraged only two or three feet from their nest. Indeed, as far as I have seen, thornbirds make little effort to drive away birds of other species, not even those intent upon appropriating their nests, a matter which will be treated in detail in Part II of this paper.

The territoriality of thornbirds is also manifested by their attempts, often



FIG. 2. A large nest of the Rufous-fronted Thornbird on the Venezuelan *llanos* at hato "El Milagro" in the state of Cojedes. 22 July 1966.

unsuccessful, to prevent strangers of their own species from lodging in their nests (see p. 27-28).

NEST BUILDING

Site of the nest.—I found no thornbirds' nest in the midst of the thickets where they forage. For their nest site they prefer a tree standing alone, in a pasture or cultivated field or beside a road (Fig. 2). Such a tree may be as much as 50 yards from the dense, low vegetation that affords them food and concealment by day. If no completely isolated tree is available, they select one growing with only a few others, or even one at the edge of a thicket or patch of woodland, beside an open field, a roadway, or a pond. In such cases the birds place their nest on the more exposed side of the tree. Their goal seems to be a nest hanging in an open space, untouched by surrounding branches. Occasionally a dangling vine is chosen to support the structure.

The nests that I saw in northern Venezuela ranged in height from seven to about 75 feet above the ground. Both of these extremes were found in the same locality on the *llanos* of the state of Cojedes. The lowest nest was



FIG. 3. A nest of the Rufous-fronted Thornbird built on a horizontal bough of an *Erythrina* tree, photographed in the dry season when the tree had shed its foliage. Pirapira, Carabobo, Venezuela, April 1966.

completed but contained neither eggs nor young. The highest was in a large, spreading tree with an open crown in which a flock of Wood Ibises (*Mycteria americana*) were resting. At Pirapira the vertical range of nests was somewhat less. The lowest that I noticed, only eight feet up, was never finished. The highest was at about 50 feet.

The thornbirds build their nest at or near the end of a slender leafy branch at the outside of the tree's crown, often at the bottom of the crown. At times the nest is placed upon a horizontal or even an ascending branch, but usually a drooping branch is chosen, sometimes one which hangs vertically (Fig. 3). The thornbirds' nests which most often catch the attention of the hurried traveler are large structures dangling from vertically descending, often leafless, branches (Fig. 4). Such nests tend to create a false impression of the kinds of sites which thornbirds choose. Many of these nests were begun on slightly descending, or even horizontal, leafy branches, which gradually sank beneath the weight of the growing mass of sticks, lost their foliage, and finally died. All the nests that I noticed in early stages of construction were on leafy branches, with lateral twigs to prevent the nest from slipping off.



FIG. 4. A nest of the Rufous-fronted Thornbird attached to a hanging woody vine. About seven feet long, this nest was the tallest seen. Hato "El Milagro," Cojedes, Venezuela, 22 July 1966.

In Central America, I have seen the bulky globular nests of the Red-faced Spinetail (*Cranioleuca erythropis*) and the Rose-throated Becard (*Platypsaris aglaiae*) hanging from slender branches in just such sites as thornbirds might have chosen.

Thornbirds sometimes build amid colonies of oropendolas and caciques. At "La Araguata" a nest was placed high in a Spanish plum tree (*Spondias* sp.) that held seven nests of the Crested Oropendola (*Psarocolius decumanus*), and on the *llanos* I found two large thornbirds' nests in the midst of a colony of 13 active nests of the Yellow-rumped Cacique (*Cacicus cela*) (Fig. 5). The nests of the thornbirds and those of their icterid neighbors were built at the same height and in quite similar situations, at the ends of slender drooping branches, with the difference that the woven pouches of the icterids hung free below the tips of the twigs, while the thornbirds' castle of sticks was built up around the supporting branch.

Exceptionally a nest is built around the upright main trunk of a slender tree. One such nest that I noticed was a large structure that surrounded, for a distance of several feet, the trunk of a young cecropia tree; but this nest had been abandoned. Along the



FIG. 5. Two nests of the Rufous-fronted Thornbird (the largest masses, left and right center) in a colony of 13 active nests of the Yellow-rumped Cacique. Hato "El Milagro," Cojedes, Venezuela, 22 July 1966.

highway between Caracas and Valencia, I saw several nests on service poles, supported by the cross-arm or the struts which strengthened it. At "La Araguata" I discovered a pair of thornbirds building on the stub of a petiole of a dead frond of a yagua palm growing in a pasture. The nest site, about 30 feet up, was behind hanging dead fronds, old dry spathes, and richly branched spadices from which the flowers or fruits had long since fallen. The birds had difficulty passing their material through all this drapery, which sometimes knocked a stick from their bill. This most atypical nest was never finished.

Gathering and placing the sticks.—Aside from the lining, the thornbirds' nest is composed wholly of sticks, which are often two or three times as long as the six-inch bird who raises them high into the trees. The longest stick that I found in a nest measured 21 inches. Sticks over a foot in length are frequent, but many are only a few inches long. The thicker ones are about a quarter-inch in diameter—the thickness of a lead pencil. Many of the sticks are fairly straight and branchless; some are crooked or branched. At Pirapira, where there was abundant rainfall during the wet season and most of the woody plants were thornless, the majority of the sticks brought

to the nest were not thorny. Probably in more arid districts, where the vegetation bristles with spines, our bird uses enough thorny twigs to justify its name.

Occasionally, building thornbirds attempt to break sticks from trees, and they may even deliver a few woodpecker-like pecks to recalcitrant twigs; but unless the piece is far advanced in decay, it will not yield to the tugs of their slender bills. If not transferred from an earlier nest of the same pair, most of the sticks used in building are loose ones gathered on or near the ground. The bird grasps a single twig in its bill, at or near the point of balance, and may hop and flit upward through the nearest shrubs and trees to a point near or even above the level of the nest, which it may then reach by a horizontal or slightly inclined flight across the intervening open space. The heavier the piece, the more the bird seeks the aid of convenient branches to raise it gradually to the nest, resting here and there on the way. Often, however, the stick is borne upward on a fairly long and strongly ascending flight. Sometimes the bird's rapidly beating wings barely suffice to raise it aloft, and occasionally it is borne downward by the weight of its burden. Although they live so much amid thickets where there is little need for long flights, thornbirds are strong and swift flyers.

After it has chosen a stick, the thornbird shows an indomitable will to carry it to its destination. It displays considerable skill in maneuvering the clumsy piece through obstructing twigs, but now and then the stick is knocked from the bird's bill. On one occasion a builder bringing a long, branched twig to its nest lost its balance when the piece struck an obstruction; but the bird's grip on the stick was so tenacious that bird and burden fell four yards to the ground together. Losing no time, the bird carried the piece to the base of the rough, leaning trunk of the nest tree, up which it crept and hopped with its heavy load to the supporting branch, then flitted along this bough to the nest. Unlike the Firewood-gatherers (*Anumbius acuticaudatus*), of whose stupid neglect of fallen sticks Hudson (1920, I:225) wrote, thornbirds frequently retrieve pieces that they drop from the nest. I have repeatedly seen them dive straight downward 25 feet or more to the ground in pursuit of a falling stick, then return it to the nest by a circuitous course. Although twigs which slip unperceived from the bottom or sides of the nest may be allowed to remain on the ground, I have not seen a large accumulation of dropped material beneath a recently built thornbirds' nest.

My best opportunity to watch the very beginning of a thornbirds' nest was lost by the necessity to make a trip to Caracas to obtain official permission to prolong my sojourn in Venezuela. During the two days of my absence, this pair of birds started their nest by lodging sticks near the end of a slender, descending, leafy branch of an algarrobo tree (*Hymenaea courbaril*), at a

point where a curvature of the branch and lateral twigs provided support. This initial stage was doubtless the most difficult part of the whole building operation. When I returned, the builders had a small platform of sticks on which they could stand while they added more to their structure. From this stage onward, I have watched building at a number of nests.

Nearly always one finds two birds working in closest cooperation, although occasionally, as will be told in due course, they have a helper or two. Building proceeds with much singing, by means of which the partners keep in touch and encourage each other while separated by their search for sticks, with duetting and twittering when they come together on the nest. Despite the strenuousness of their task, the birds seem to enjoy it! Often, after alighting on the nest with a long stick laboriously raised to it, the builder continues to stand for a short while holding the piece in its somewhat raised bill, sometimes waving it around, in what appears a foolish, abstracted attitude. I surmised that the bird felt about its burden much as I did about the heavy stepladder that I carried for long distances across the fields to examine thornbirds' nests: although eager to be relieved of the load, setting it down was so awkward an operation that I sometimes stood holding it for some seconds after I had reached my destination.

Its moment of abstraction over, the bird proceeds to fit the new piece into the nest. The placing of the stick seems not to be preceded by a survey of the structure leading to a decision as to just where the latest contribution is needed and will be deposited. On the contrary, the thornbird holds the stick near the middle, with one end lower than the other, and makes sideward movements with its head while it continues to step about over the nest. Often it must repeat these apparently random movements a number of times before the lower end of the stick—more or less by accident, it seems—slips in between those already present. Although sometimes the new piece is promptly accommodated in the fabric, at other times minutes are spent with a recalcitrant stick that does not seem to fit anywhere. Such a stick may finally be laid loosely on top of the others. The attempt to push the new twig into the nest is accompanied by a vibratory or jerking movement of the head, which keeps the end of the stick in slight agitation until it encounters an interspace which it can enter, then facilitates its passage through the maze of interlaced sticks. If the new twig fits too loosely, the bird may pull it out and continue to poke it sideways as before. After finally placing a new piece, the builder often seizes in turn the projecting ends of a number of sticks, testing their stability and pushing them deeper into the fabric if they are loose. Instead of bringing more sticks, the birds may devote five or ten minutes to arranging materials already present, sometimes removing

loose sticks from the bottom of the nest and working them in at the top. This continual testing and rearranging makes the fabric strong.

One day I watched a thornbird trying to pull up a very long stick that had slipped through the bottom of a newly started nest but was prevented from falling by a fork at its upper end. With its bill, the bird drew up the stick as far as it could; but as soon as it released its hold for another lower on the stick, the piece slipped down until stopped by the fork. The bird tried this a dozen times, sometimes pulling the stick almost halfway out; but always the stubborn object fell back after the bird had lifted it as far upward as it could stretch and needed a lower hold to complete the operation. In the end, the thornbird flew off leaving the stick dangling below the nest. By using a foot to retain the stick while it secured a new grip with its bill, the bird might easily have solved its problem. Likewise, it might have drawn out the stick with its mate's cooperation. But thornbirds seem never to use their feet for holding things, and the manipulation of each stick is always the task of a single bird.

Helpers.—As a rule I found only two birds working at a nest, and this was invariably true at nests in which only a mated pair slept. But when more than two grown birds lodged together, more than two might join in building. At nest 3, a large structure that was occupied nightly by three thornbirds who kept close company and two more who appeared to be intruders (see p. 27–28), three built actively for a while, adding a new chamber, on the morning of 30 April. At other times, however, I found only two birds working at this nest and its successor. When three were at the nest together, they uttered many, low, squeaky notes; when only two were present, such notes were far less frequent than song.

Nest 11 was occupied by six grown birds who seemed to form a united family; and when a new structure was started close by it, three individuals built actively, as I saw during prolonged watches on two mornings. All three brought many sticks and arranged them in the nest. At times five or six birds were present, but I was not convinced that all were contributing to the new construction. Once, indeed, I saw four individuals carrying sticks simultaneously, but one of the birds deposited its burden on the neighboring old nest, from which the more active builders were transferring materials to the new edifice. After visiting the nests briefly, the second trio would drift away, leaving the other three at work.

At nest 16, in which four grown birds slept, at least three either adjusted sticks already present or brought new ones, at a time when active building had ceased. Four birds were sometimes at the nest in the daytime, but without being able to distinguish them individually, I failed to prove to my satisfaction that all contributed to the maintenance of this structure. At still another nest, a third thornbird occasionally brought a stick.

Gilliard (1959a:19) "observed four birds building a nest at one time. Once two of them were side by side on the top vigorously arranging sticks, when a third, which was carry-

ing a stick, arrived and landed beside them." The additional birds that engage in building are apparently grown offspring of the mated pair (see p. 40).

Rates of working.—When building a new nest or actively enlarging an old one, thornbirds begin work soon after leaving their dormitory at daybreak, after an interval in which doubtless they find their breakfast. In the cool early morning they start off with great energy, but they seem soon to tire of their strenuous task; their trips to the nest with sticks become more widely spaced, and by the middle of the forenoon they as a rule rest from their toil. On 30 March, two birds working at a recently begun nest brought 31 contributions from 06:35 to 07:35, 12 from 08:30 to 09:00, but only one from 09:00 to 09:30. On 15 May, three birds brought material 38 times between 07:20 and 08:05, 12 times from 08:05 to 08:25, and three times from 08:25 to 08:45. Some of these sticks were taken from an older nest hanging a few yards away, greatly reducing the task of gathering material. At another nest, three birds brought 36 contributions in the hour between 07:00 and 08:00 on 3 April. On 31 May, from 08:40 to 09:40, two of these birds brought 25 sticks to a replacement nest, taking some from the older structure. After their concentrated building in the early morning, thornbirds may work sporadically at their nest at almost any hour of the day; and in the evening, shortly before they retire for the night, there may be a brief spurt of active building.

Removing foliage.—While building, thornbirds are often bothered by the leaves which cluster around their growing structure, impeding the arrangement of their long sticks. Sometimes the birds push the disturbing leaves outward, only to have them return to their original position after they are released. More often I have seen the builders try to tear away the offending foliage, usually with little success, for their bills are ill-fitted for such work. Sometimes the thornbirds reach far up to seize a leaf with a foot while they tug at it with their bill. One thornbird clung to a large mango leaf with both feet while pulling it with its bill. Occasionally the bird pecks the recalcitrant leaf. Although such leathery leaves as those of the mango are obdurate to the thornbirds' efforts, by dint of great persistence they do succeed in detaching small leaflets from compound leaves, or in tearing pieces from the edges of leaves. In removing some of the leaves which cluster around their nest, thornbirds differ from most other arboreal birds, which seek concealing foliage. The removal of leaves to increase exposure is known to occur in a few species of birds of which the males display for an extended period in one particular spot, such as the Blue-backed Manakin (*Chiroxiphia pareola*) (Gilliard, 1959b), the Magnificent Bird of Paradise (*Diphyllodes magnificus*) (Rand, 1940), and occasionally in the Orange-collared Manakin (*Manacus aurantiacus*) (Skutch, 1969).

Lining the nest.—If, while searching for sticks, a thornbird finds some soft or flexible material—a feather, a fragment of reptile skin, a shred of fibrous bark, a scrap of paper or cellophane, or the like—it may bring the piece for the lining, even to a nest that is still hardly more than an open platform. I never saw thornbirds concentrate on lining their nest, as many other birds do; but they bring appropriate material as they find it, not only while

building but also with frequency while incubating their eggs, and even occasionally while feeding nestlings. One family of thornbirds tore apart an old covered nest of a Great Kiskadee (*Pitangus sulphuratus*) to augment the lining of their own bulky nest, which had long been finished.

Completion of the nest.—As building proceeds, the sides of the platform of sticks with which the nest begins are built up faster than the center, converting it into a shallow bowl and then a deeper cup. Then the walls contract inward, until finally the hollow is roofed over, becoming a nearly spherical chamber. Instead of proceeding to thatch this chamber with broad pieces of material, as castlebuilders (*Synallaxis* spp.) do, the thornbirds continue to bring more sticks and build a second, similar, chamber above the first. The first surge of building activity rarely dies away until this upper chamber is covered with at least a few sticks, and sometimes it persists until a third chamber is begun atop the second.

Since thornbirds are indeterminate builders, adding to their structure at all seasons, while they incubate and even occasionally while feeding nestlings, it seems incorrect to say that a nest is ever completed. However, after the upper chamber is at least loosely covered, some pairs relax their efforts, and the nest may be considered as temporarily finished.

In April, one pair took only 10 or 12 days to build a two-chambered nest, with the upper compartment scantily roofed; and after this they rested for five weeks before they began to lay. Later in the season, in July, another pair started to lay about 18 days after they began their nest, at which time their upper chamber, although well lined, was still an open cup without a vestige of a roof. Yet this second pair, which built more slowly, transferred much of their material from their older nest only two yards away; whereas the first pair had no such convenient quarry and perforce sought their sticks at a greater distance.

Two-chambered nests, which are the smallest ones in which, as a rule, one finds thornbirds sleeping or breeding, may be about 15 or 16 inches high and from 9 to 14 inches in diameter, not counting the ends of sticks which on all sides project far beyond the main mass, giving the nests a bristly, unkempt aspect. The globular chambers that they contain are about 4.5 to 5 inches in diameter. The entrances to these chambers take various forms. That of the lowest chamber, in which the brood is usually raised, may be an upwardly directed passageway through the sticks, which here bulge out farther than on the other sides of the nest. This passageway may be five or six inches long by about two inches in diameter. Sometimes it is shaped like the spout of a teakettle, and it may dilate inward so as to form a sort of vestibule or antechamber in front of the main chamber. Very often the entranceway bends in one direction or another, so that one cannot look

straight down it and see what is inside the nest; but sometimes it has a simpler form that makes inspection easier. Although typically the external opening of the lowest chamber is near the top of a two-chambered nest, if the supporting branch has sunk far downward under the structure's weight, rotating its long axis through nearly 90 degrees, the doorway may be at the side, near what has now become the bottom of the structure. In an old nest with a number of compartments, the entranceways may take various directions, some leading downward to the chamber, others upward, and yet others horizontally; but as a rule all open on the same side of the nest. Each compartment has its own opening to the outside and there is no internal communication between them; they are separated by partitions formed of interlaced sticks.

The chambers are lined on the bottom with almost any soft or flexible material that the thornbirds find. The lining of one nest was composed largely of strips of fibrous bark; that of another, in the midst of a pasture, of fibrous pieces of decaying stems and leaf-sheaths from the tall grass. Thin and curving pieces of material are preferred to wide ones; but in one nest I found broad flakes of inner bark, apparently from a neighboring woodpile, and a piece of decaying wood 5 inches long by $\frac{7}{8}$ inch broad, as well as some small shrivelled leaflets. Nests near human habitations have more varied contents, including scraps of cellophane, pieces of plastic bags (in one case six inches square), brightly colored candy wrappers, tinfoil, paper, feathers, etc., as well as vegetable fibers, scraps of wood, and strips of bark. I was told by a Venezuelan that the place to look for a lost love-letter is in a *guaiti's* nest! The presence of lining in a compartment cannot, as I once supposed, be taken as an indication that it has been, or will be, used for breeding. An unfinished upper chamber may be as well, or better, lined as that which contains the eggs. While incubating, the birds may deposit at least as much new lining in an upper chamber as in the one where their eggs rest.

From time to time, the thornbirds add a new chamber to the top of their nest, or to the higher side if it is on an inclined rather than a vertical branch, until it becomes an enormous mass, all out of proportion to its diminutive builders. They are so strongly attached to their nests that they might continue all their lives to enlarge them, but a limit is often set by what the supporting branch will bear. It may break under the growing weight, or, as seems more frequently to happen, an angle or curvature of the branch makes further upward building impracticable. It was doubtless no accident that the tallest nest that I saw was built around a long, slender, vertically hanging liana, which seemed to invite the thornbirds to build up and up indefinitely (Fig. 4). This inaccessible nest, on the *llanos* of Cojedes, was

estimated to be seven feet high, and it appeared to contain eight or nine chambers. Nests three or four feet high, with four or five chambers, are not uncommon. Usually the chambers are in a single series, one above another; but an exceptionally broad nest, measuring about 20 inches in height by 18 inches in diameter, contained one chamber in the bottom and two, side by side, at the top. I was told of thornbirds' nests that weighed hundreds of pounds, but I could procure no definite record of such heavy structures.

Despite their considerable weight, thornbirds' nests seem rarely to fall unless the branch that supports them breaks from the tree. They do not become detached from the branch because they are built around it; it is firmly embedded in the wall, usually at the rear. Despite the simple technique used in their construction and the lack of any cement or other binding material, the wall surrounding each chamber is surprisingly strong. To make an aperture large enough to insert a small mirror and electric bulb for viewing the eggs, I forced a stout pointed stick into the fabric, which I could hardly open with my fingers. After each inspection, I worked twigs into the gap to close it; and the birds seemed not to notice what I had done.

Significance of the multichambered nest.—A thornbirds' nest is notable for its magnitude rather than its comfort or elegance. Made of a single kind of material, lined with almost anything soft or flexible that the birds can find, it is a crude construction compared to the smaller, single-chambered nests of certain species of *Synallaxis*, notably *S. erythrothorax*. These more secretive, less sociable birds may use sticks of different sizes for different parts of their structure; their lining is of a single, carefully selected material, often of soft downy leaves, which may be shredded and felted together; nearly always the chamber that shelters the eggs and nestlings is thickly roofed with broader pieces which shed the rain. Thornbirds make no provision to keep the interior of their nest dry; the top is covered with sticks no thicker than those in the walls and floor. Probably little rain seeps into the lower chambers of very large nests; but in a nest with only two compartments, the loosely covered upper one must serve as a basin to catch the rain water, which pours through the thin floor into the lower chamber where the birds sleep or attend their eggs and young. I have many observations that thornbirds, although they inhabit semi-arid country, care little for dryness. I repeatedly failed to find them taking shelter in their nest from a daytime shower; and a rain in the evening hardly advances their time for retiring. They may begin to sleep in a new nest while it is still a roofless cup. A family whose nest tree was cut down retired at nightfall into the hollow end of a rotting stub that afforded some concealment but no protection from the downpours frequent at this season. Although thornbirds inhabit some of the drier parts

of the tropics rather than rain forest, the wet season, when they breed, may be a period of heavy rainfall.

The large nests of thornbirds remind one of the many-chambered structures of the Social Weaver (*Philetairus socius*) of southern Africa, the Gray-breasted Parakeet (*Myiopsitta monachus*) of southern South America, and the Palm-Chat (*Dulus dominicus*) of Hispaniola. These birds, as is well known, build compound nests in which a number of pairs breed, each in its own compartment. The suggestion has been made (Gilliard, 1958:262-263) that the thornbirds' nest is similarly an avian apartment house; but none of the score of nests that I investigated was occupied by more than one breeding pair, in some cases with additional, self-supporting but nonbreeding individuals, who were evidently their offspring of the preceding year. The strong territoriality of the Rufous-fronted Thornbird would prevent social nesting.

Why, then, do thornbirds start with two-chambered nests, to which additional compartments are from time to time added? One possibility is that the complexity of the nests might make it more difficult for predators to find the eggs or nestlings. A snake or small mammal, advancing along the supporting branch, would first reach the upper chamber, in which breeding rarely occurs—only, in my experience, when the lower part of the nest is occupied by intruders of another species. Finding nothing edible here, the predator might abandon the search; and even if it did not, the delay caused by the upper chamber might give feathered nestlings time to escape. In case of a night attack, the delay might save the lives of the grown birds sleeping in the lower compartment. That the complexity of the nest does make it difficult to find the eggs I can attest from personal experience. I was watching for laying to begin in a recently completed nest, which I periodically examined while balancing myself on a high, self-supported ladder that restricted my movements. On my earlier visits of inspection, I had looked only into the upper chamber and the antechamber of the lower one, which I mistook for the lower compartment itself. Then one day, after I had been examining the nest for several minutes, a thornbird flew out past my face, evidently having come from some part of the bulky nest that escaped my scrutiny. Thereupon I made a hole in the side and, inserting my light and mirror, saw two eggs which the bird had been incubating—the first thornbird's eggs that I ever saw.

While attending eggs or nestlings, parent thornbirds enter the unoccupied chamber(s) of their nest with confusing frequency, and one may have to watch a long while to learn just where their progeny lie. An approach to the two-chambered nest of the thornbird is found in the nest of the Barred Waxbill (*Estrilda astrild*) of Africa, which builds a domed structure entered

through a tubular lateral tunnel from 5 to 14 inches long. Surmounting the dome is an open cup, resembling the nest of many a small bird, to which the function of diverting attention from the brood chamber below has been ascribed (van Someren, 1956:492). A similar function was long ago attributed to the always eggless "dummy" nests of various species of wrens. It is now known that these nests serve as dormitories, or they are built by the male to give the female a choice of sites; although neither of these functions precludes the one earlier attributed to them, that of confusing predators. Like the nests of certain wrens, those of thornbirds are used as dormitories, and the upper chamber may serve as a bedroom for the nonbreeding members of the family while the parents incubate eggs or brood nestlings in the lower one.

Against the theory that the complex structure of the thornbirds' nests serves to confuse predatory animals weighs the fact that, despite their strength and relative inaccessibility, they are frequently pillaged. Of their use as dormitories there is no doubt; but a smaller nest with a less permeable covering would, it seems, make a drier and more comfortable bedroom. Whatever we may finally conclude as to the selective advantages which have favored the evolution of these ponderous nests, it is evident that they represent one of the fullest expressions of a propensity widespread in the family to which the thornbirds belong, as in certain other tropical families, such as the wrens: that of building for its own sake, of constructing or bringing additional material to nests as an outlet for excess energy or a pastime. This tendency, evident in the castlebuilders (*Synallaxis*), is carried to far greater lengths in the massive structures of the Rufous-fronted Thornbird and certain other South American members of the ovenbird family of which Hudson (1920) has given us fascinating glimpses, but of which adequate modern studies are still lacking.

Attachment to the nest site.—The sedentary thornbirds cling stubbornly to their chosen homesite. As long as they can, they add new chambers to their old nest rather than start a new nest. If their nest falls, they build another as close to the old site as they can. The same occurs when the old nest is taken from them by some stronger bird, such as the Troupial (*Icterus icterus*), or after they have built upward to the limit of the supporting branch. When they have been robbed of eggs or nestlings, they either lay again in the pillaged structure, often in the same chamber as before, or build a new nest nearby. These masses of coarse sticks last a long while, even after they have been abandoned; and one often finds two, and sometimes even three, hanging conspicuously from the same tree. In one case, a family of thornbirds, finding it no longer practicable to add a chamber to the top of their nest in the usual manner, built a new nest below the old one, at the end of the

same branch, which had grown longer since the earlier structure was started. When the new nest was finished, the projecting ends of its sticks overlapped those of the old nest above it. I surmised that with time the two nests would be fused indistinguishably; but before this could occur, the overladen bough snapped off and all the birds' work was lost.

Although the growing weight of thornbirds' nests usually makes them sink lower, occasionally the reverse occurs. A nest built in a mango tree in the midst of green fruits rose about two feet when the mangos ripened and fell, relieving the supporting branch of much of its load.

OCCUPANCY OF DORMITORIES BEFORE THE BREEDING SEASON

On the evening of 16 March, the day after our arrival at "La Araguata," I watched a three-chambered nest that hung conspicuously, 13 feet up, from a tree growing in a fence line between pastures, close by the farm buildings. Nearby the Diesel engine that drove the electric generator was chugging loudly. At 18:50, when the light was growing dim, I heard repeated sharp notes. Soon several thornbirds appeared low in the weedy fence line about 100 feet from the nest. Passing through the pungent fumes from the engine, seeming not to be troubled either by its noise or by my unconcealed presence, they advanced, staying among the herbage near the ground. When near the nest, they flew up to it, either directly or by way of a neighboring tree. Four entered through two separate doorways, and after a few minutes two more joined them. It was then nearly dark. Although in the four days that I had already spent in Venezuela I had noticed many thornbirds' nests along the highways, these were the first thornbirds that I saw, with the exception of two that flew from a roadside nest as we speeded by.

At 06:25 next morning, as it was growing light, I watched the six thornbirds fly from their nest. After leaving, they vanished down the fence line, uttering a few sharp notes. Soon they sang amid the dense vegetation on a bank beside a neighboring stream.

It was then the height of the long, severe dry season, which was to last well into May. As I became more familiar with the farm, I found enough thornbirds' nests to suggest that they were among the most abundant birds in the area; although the thornbirds themselves remained so well hidden that I rarely saw them except while I watched their nests. There was still no sign that they were breeding, and I decided to make a survey of the nests and learn how many thornbirds slept in each. The counts could be made only as the birds entered at nightfall or emerged at dawn, hence no more than two in a day. Since the birds darted in or out very quickly, sometimes it was necessary to count a second or third time for certainty. By 1 May, I had investigated 14 nests situated within about a mile and a half of my residence. Although rarely I counted seven birds at a nest, I could never repeat these counts; either I miscounted, or the seventh bird was an intruder who did not continue to sleep in the nest. No nest that I studied had more than six regular occupants; three nests had this number. One nest was occupied

nightly by five thornbirds; at another, I sometimes found five and sometimes four. In each of three nests there were three sleepers. Six nests were occupied by pairs of birds. In May and June, when many thornbirds were breeding but there were still no independent young of the year, I investigated eight additional nests, finding in each no more than two birds past the nestling stage. Thus, before the number of grown birds was increased by young hatched in the present season, 14 out of 22 nests, or 64 per cent, were occupied by only a mated pair. These couples without grown companions were, I believe, in most cases either young birds who had not previously nested, or older ones who in the preceding year had tried vainly to rear young.

In general, the thornbirds retired late in the evening and arose early in the morning; but there was a good deal of variation between nests, and even between the several occupants of the same nest. The birds who slept near the noisy electric plant went to rest very late, when little daylight remained, possibly because of this and other disturbances. But even farther afield, where there were no sounds save those of the natural world, families differed in the hours they kept. The six birds who slept in nest 11 flew forth in the dim light of dawn, so early that after watching them leave I could reach nest 17, 100 yards away, some minutes before the six sleepers left this nest. Similarly, these birds retired earlier than their neighbors of nest 11. And even at a single nest with three or more occupants, the first might enter 10 or 15 minutes before the last. The latest arrivals, who might enter in the dusk when there was hardly enough light to see them, were, at least in some cases, intruders rather than members of the family. These interlopers will be considered in the following section.

When only two thornbirds occupied a nest, I always found them sleeping in the same chamber, whether or not they had eggs or nestlings. When three or more were present, it was often difficult to learn how they distributed themselves among the several available bedrooms. Often they would enter by different doorways, but then they might shift from chamber to chamber; and these restless movements would continue until the light had become so dim that I could hardly distinguish the dark birds as they crept rapidly over their dark nests from one entrance to another. In the growing obscurity, I could never be sure that I had witnessed the last of these changes. Similarly, in the dim light before the birds flew down at dawn, they would often shift from chamber to chamber; and I could not be sure that this activity had not started before there was enough light to reveal it to me. Another difficulty was that if I paid too much attention to how the birds distributed themselves among the available bedrooms, I was likely to miscount the number that entered or left the nest as a whole.

Despite these perplexities, repeated observations convinced me that the thornbirds were not consistent in their occupancy of the available chambers. At times one would force its way in with others who resisted its intrusion, when it might without opposition have entered another compartment of the same nest. Parents with eggs or nestlings sometimes tried to exclude their older offspring from the brood chamber, not always successfully. On the other hand, the several occupants of a nest might elect to sleep in different chambers when there was no evident antagonism among them. Thus, at nest 1 on the evening of 17 March, four birds entered the top compartment, two the bottom compartment, of this three-chambered structure. One of the latter soon emerged and went to the middle chamber, so that, apparently, four birds slept together and two singly, in different chambers. Two evenings later, two birds retired into the top compartment of this nest, three into the middle compartment, and one into the bottom compartment. At daybreak on 20 April, all six of the occupants of this nest emerged from the middle chamber, where apparently they had passed the night; but before flying down, two of them briefly entered the top chamber.

Since nest 1 was much closer to the house than any other that had more than two occupants, I was able to follow the vicissitudes of this family in most detail. During the second half of March, I consistently found six birds lodging in nest 1. On 10 April only three entered, but on 13 April four emerged at dawn. By 20 April all six were again in residence. On 4 May the number of occupants was reduced to four, and during the following night only two were present. This time I discovered where the others had gone. A new nest was being built about 350 feet away, in the direction that this family took to forage. On the night when only two slept in the old nest, four occupied the new one. For some unknown reason, the new nest was abandoned a day or two later, and then I again found six sleepers in nest 1.

On the evening of 20 May, I clearly saw seven birds enter this nest. One was an intruder who did not stay, and on the following nights only six were present. This was the last time that I found six birds at this nest. On 6 June there were four; on 12 June, five; and on 16 and 28 June again four. As far as I saw, nest 1 had during the last three months failed to receive the usual maintenance care, its occupants neither bringing new sticks nor tucking in loose ones (as happens at most nests), and it had become dilapidated. Indeed, it would have fallen if I had not tied up the supporting branch before it broke from the tree. By 5 July the mated pair at this nest, after several failures to establish a home at a distance, had started a new nest only six feet from the old one. By this time the number of occupants of nest 1 had been reduced to three—the building pair and one other—and all moved to the new nest a few days later. Possibly the noise and fumes from the electric plant, or the distance of nest 1 from the foraging area, had caused this pair to depart at first from the usual practice of building their new nest in the tree that holds, or held, the old one; but after two, or possibly three, nests that they had built at a distance had been abandoned for reasons unknown, they at last laid their eggs in the new structure in the old familiar tree.

At more distant nests, where I counted the occupants at longer intervals, I failed to notice such temporary fluctuations in their number as I recorded at nest 1 in April and May. It was evident, however, that during these months the composition of the families remained nearly constant. Twelve nests, at which I first counted the birds from mid-March to the end of April, had at this time a total of 44 occupants; and in late May these 12 nests or their

replacements still had 44 occupants, not counting nestlings. In one nest the number of lodgers had fallen from three to two, but in another it had risen from three to four. In June and July, the larger families began to disperse, a process which was perhaps accelerated by the loss of nests from the breaking off of branches and the felling of a tree. Of the three largest families present in March and April, I have already recorded the dissolution of that which occupied nest 1. The six birds of family 11 remained together through May, moving successively to two newly constructed nests when their dormitories were invaded by Troupials, but by late June their number was reduced to four. The six grown birds who in late April occupied nest 17 were still present in early June, when their family had been increased by two fledglings; but by 21 July three of the eight had vanished. Apparently in June and July, when many pairs were incubating or feeding nestlings, yearlings were leaving the parental abode to seek mates and establish homes of their own. Observations reported in a later section of this paper suggest that their departure may have been hastened by the antagonism of the breeding pairs.

The Rufous-fronted Thornbird is by no means the only member of the ovenbird family that sleeps in a dormitory. According to Hudson (1920, I:224), the young of the Firewood-gatherer sometimes "remain with their parents for a period of three or four months, all the family going about and feeding in company, and roosting together in the old nest." Other members of the family roost singly. The Plain Xenops (*Xenops minutus*), which nests in a cavity excavated in a decaying stub by itself or by a piculet, sleeps alone in an old woodpecker's hole or some other cranny in a tree. The Red-faced Spinetail (*Cranioleuca erythrops*) sleeps singly in a bulky hanging nest of moss and other soft materials, such as it uses for breeding. In the coastal range of Venezuela, Paul Schwartz showed me mossy inverted pockets, attached to the rocky face of a highway cutting, in which Spotted Barbtails (*Premnoplex brunnescens*) slept, always alone. Much remains to be learned about the sleeping habits of ovenbirds.

BEHAVIOR OF BIRDS THAT LOST THEIR NESTS: INTRUDERS

As the sun set on 29 March, I stood beside an unpaved roadway, watching a large nest with several compartments that hung from a tree standing alone in the adjoining pasture. At 18:55, in the fading light, a thornbird flew up from the roadside bushes and entered the central compartment of this nest. It sang loudly and was answered by song from across the road. In a minute or so, it was joined by two more birds. Then, after an interval of about 10 minutes, when it was nearly dark, another bird entered the nest, causing an outburst of song within. A minute or two later, still another bird went into the nest. Although at first these late-comers entered different compartments, all the five finally settled down, I believe, in the central chamber. This was practically a repetition of what I had witnessed at this nest four evenings earlier.

Nearly two months passed before I again, on 25 May, watched this distant nest at nightfall. Two thornbirds arrived almost together, sang loudly while resting on the front of the nest, then entered the middle compartment. A minute or two later, a third bird joined them there. Then many minutes passed before another thornbird appeared. It perched in a roadside tree and uttered low, sharp notes, seeming to be nervous about approaching the nest. Finally, it flew up to the structure, only to dart away a moment later. Then, when the light had become dim, this bird and another flew up to the nest at the unusually late hour of 19:07. Now excited twittering came from the dark structure. I could distinguish the birds only when they were silhouetted against the sky, as happened from time to time as one or more of them flitted restlessly over the nest. Finally, the movement and voices ceased, and the birds seemed to have settled down for the night; but I could not tell whether they were all together or in different compartments.

At this nest I had earlier watched three birds building a new chamber on top of the old structure. From these observations, I concluded that the three who entered first in the evening were members of the same family—probably parents and an offspring of the preceding year—while the other two were interlopers who, even after two months, had not been accepted as companions. Fresh light on the subject of intruders was unexpectedly gathered three weeks later, when, to my intense annoyance, I found that the tree that supported this nest had been newly felled for posts. In the deepening twilight of the day on which the tree was cut, or perhaps the day after, I discovered one of the thornbirds flitting through the roadside trees, dismayed by the loss of its lodging. Finally it vanished amid the foliage, where doubtless it slept that stormy night.

When I returned late on the following afternoon, there was a handful of sticks far out on a slender, descending branch of a small tree that grew beside the stump of the recently felled tree. The thornbirds deprived of their old nest had already started a new one, only eight feet above the ground. At about sunset, three of them came and stood on the small accumulation of sticks. Then they flew back to the roadside bushes, but ten minutes later the three again alighted on the incipient nest. They did not remain here, but entered the hollow end of a lichen-covered stub in a neighboring tree. This cavity, only 12 feet above the ground, not only had a wide gap in the side but was completely open above; it offered no protection from the heavy rains of this season but afforded some concealment and doubtless gave the thornbirds the sensation of being in an enclosed space. After nervously going in and out a number of times, and peering forth intermittently as the light grew dim, the three thornbirds, evidently feeling insecure in their strange lodging, settled down to pass the night in the hollow stub. Yet in plain view of this stub, not 100 yards away, hung a very large, multichambered nest in which a pair of thornbirds and a pair of Piratic Flycatchers (*Legatus leucophaeus*) were incubating. Here the three might have found a drier lodging.

What had happened to the other two thornbirds who had slept in the ruined nest? After the trio had retired into the stub, I heard a thornbird's *chip*'s in the roadside shrubbery near the felled tree. These low notes betrayed the bird's progress along the bushy roadside toward the high nest where the thornbirds and flycatchers incubated. It was now about 19:20, long past the thornbirds' bedtime and nearly dark; but the high nest was silhouetted against the sky, with a wide clear space in front of it. Soon the dark figure of a thornbird passed across the clear space to this nest, which it seemed to enter. Low notes came from the nest, then a bird flew out. Soon, however, it returned; and this time it stayed, apparently in the compartment with the incubating birds of its own kind rather than with the Piratic Flycatchers. The last dull glow of sunset

was then fading from the dark clouds low in the west. I failed to find the fifth occupant of the ruined nest.

Although the three thornbirds who formed an integrated group had respected the territory of their neighbors when their neighbors' nest might have afforded welcome shelter, the unattached bird had no such inhibition. Taking advantage of the dim light, it had boldly forced itself into a nest where it was not wanted. This observation helped to explain some of the fluctuations in the number of occupants of a single nest that I sometimes noticed. A little later, another case of intrusion came to my attention. A nest in a roadside *Erythrina* tree had been extended upward along an inclined branch as far as possible, and then its occupants built a new nest below it on the growing end of the same bough. The four occupants of the old nest moved to the new one. Presently the overlaid limb snapped under its load, whereupon the birds started another nest on a neighboring branch of the same tree. On an evening at the end of June, when the new structure was only a platform or at best a shallow bowl, I watched to learn where the thornbirds would sleep. After sunset I found two of them bringing sticks to the new nest. Soon they settled on the platform, as though to roost there amid the foliage that clustered above it; but after staying a few minutes, they suddenly flew off in the direction of a sandbox tree (*Hura* sp.), about 250 feet away, in which there was a small nest. In a short while, the two returned to their unfinished nest, only to depart again in the same direction. Then a single bird returned, rested on the platform in the failing light, but finally flew toward the sandbox tree. The other two thornbirds who had slept in the *Erythrina* tree before the branch fell failed to appear this evening.

All this while my wife was watching the nest in the sandbox tree, a new structure occupied by a single pair. She saw four birds arrive, one by one. Two entered, but the third met resistance at the doorway. One of the first two grappled with the third, and they fell into the bushy growth below the nest. The third bird persisted in trying to force its way in, giving rise to much singing and twittering, much going in and out of the nest. When I joined my wife at this nest, the intruder was resting in the doorway with its tail sticking out into the light of the rising moon. Finally it pushed inside, causing more twitters to issue from the hanging nest.

Meanwhile, we continued to hear the sharp *chip*'s of the fourth bird coming from the low, tangled vegetation below the nest. They did not cease until the moon and stars were shining brightly. We waited until 19:35 without seeing this bird fly up to the nest; we could hardly have missed it, because it would have been silhouetted against the moonlit sky. Evidently, too timid to face the opposition of the resident pair, it passed the night amid the foliage.

On the following evening, my wife watched the *Erythrina* tree while I watched the nest in the sandbox tree. She reported that two birds came to the unfinished nest, left, came again, but after a little while flew off toward the sandbox tree. Then a single bird returned, rested on the nest, departed, and finally came back to pass the night on the open platform.

Meanwhile, at 18:47, I saw the resident pair enter the nest in the sandbox tree, followed by the usual loud singing and contented twittering. Nearly a quarter of an hour later, another thornbird flew up to the nest, but instead of at once entering the lower chamber with the first two, it remained for some minutes on the top, or perhaps on the farther side—at least, I lost sight of it. Finally, it approached the doorway of the lower chamber; but it was apparently denied admittance by the unseen birds within, for it withdrew a sort distance. Again and again it tried to enter but was repulsed. Soon it adopted a maneuver to meet this situation. After each ineffectual attempt to enter, it

turned around and stood with its tail in the doorway, reminding me of a Red-crowned Woodpecker entering tail-first a hole of which it is slightly suspicious. This about-face and presentation of its tail to, I supposed, the pecks of an unseen bird within happened many times, while the nearly full moon grew brighter and more stars shone out. Finally, at nearly 19:30, the intruder pushed in at least far enough to pass from view and stayed.

On the following evenings, the interloper entered the nest in the sandbox tree 15 or 20 minutes after the resident pair, who had evidently become more or less reconciled to its presence and seemed no longer to try strenuously to keep it out. A single bird roosted in the *Erythrina* tree, on the new nest which continued to grow slowly. By mid-July this nest had been covered over and two birds slept in it. To my surprise, the sandbox-tree nest was still occupied at night by three thornbirds, one of whom left at daybreak considerably earlier than the other two. Had the bird who all this while continued to roost in the unfinished nest in the *Erythrina* tree acquired a new partner? Or had the bird who forced its way into the nest in the sandbox tree rejoined its mate in the *Erythrina* tree, and another homeless thornbird found lodging in the sandbox tree?

By waiting until it is almost dark, when the rightful occupants have become drowsy and can hardly see the intruder or distinguish it from members of their family, homeless thornbirds become unwanted guests in their neighbors' nests. At times, apparently, they may continue for months to impose themselves upon their reluctant hosts.

THE BREEDING SEASON: THE EGGS

At Pirapira, in late March and April, when the long dry season was at its height, a number of common, wide-ranging American flycatchers (Tyrannidae), along with some other birds which subsist largely on insects caught in the air or gleaned from foliage, were incubating, attending nestlings, or even feeding fledglings, at the same time as such birds breed in the wetter climate of Costa Rica and Panamá at about the same latitude. Meanwhile, I found no indication of breeding by the many families of thornbirds that I had under observation. Like other ground-feeders, they waited until the returning rains had soaked the ground-litter and quickened the small creatures which inhabit it.

According to Schäfer and Phelps (1954:93), in north-central Venezuela the *guaití* breeds from April until September. For northeastern Venezuela, Friedmann and Smith (1955:521) indicate breeding in January and October; but it is not clear from their tabular presentation on what evidence this rather surprising statement is based. Apparently, Smith mistook building as an indication that breeding was about to follow (see Friedmann and Smith, 1950:498).

First to breed of all the thornbirds whose fortunes I followed at Pirapira was a pair that on 15 May was already feeding nestlings in an inaccessible nest in which six grown birds slept. Their eggs had evidently been laid at the end of April. This family was established on low ground near a stream, where doubtless the soil remained moister, and its insect life more abundant,

than on areas that were better drained. In another inaccessible nest, also near a stream, incubation began early in May. Although in early May there were occasional light showers and increasing humidity, the wet season of 1966 was delayed and did not become well established until after the middle of the month. During the second half of May, when rain was frequent and hard, pastures and hillsides that had long been brown gradually recovered their verdure. Now the thornbirds began to lay more freely, and by late May and June many pairs were incubating. By late July, when I left Venezuela, the pair that nested earliest was incubating a second brood, and another pair, that had so far failed to rear fledglings, had newly laid eggs. The young of this last pair could not have fledged before September.

It was not easy to see what was inside tightly closed nests hanging in mid-air, far from a trunk or branch that could uphold a climber or support a ladder. To examine the nests, it was necessary to use a four-legged ladder, heavy to carry and troublesome to set up on uneven ground. I saw only three full sets, each consisting of three eggs. These eggs were immaculate pure white, as is usual in the ovenbird family. I have seen no published record of the eggs of this common bird.

The eggs were nearly always laid in the lowest compartment, even in large nests to which a chamber had recently been added at the top. The only exception that I noticed was at a nest in which a pair of Piratic Flycatchers were established in one of the lower chambers. Here the thornbirds incubated in a newly built compartment at the top.

INCUBATION

Both sexes of the thornbird incubate, as is usual, but not invariable, in the ovenbird family. I devoted most time to studying incubation at a nest attended by a pair of which one member was quite tailless at the beginning of April and remained in this condition during the next four months. I believe that this apparently permanently tailless bird was the female; but the two partners took such equal shares in attending the nest that the designation of their sexes is of little importance. Both had bare incubation patches on their abdomens, as I saw clearly when they preened while standing in their doorway with their breasts toward me. As at other nests, both parents slept every night in the chamber with the eggs.

I watched this nest throughout the morning of 26 May and the afternoon of the following day. On 26 May activity began at 06:11 when the tailless one flew out leaving its mate with the eggs; and on 27 May it ended when the normal bird joined its incubating mate in the nest at 18:52. Considering the two consecutive half days as the equivalent of one whole day, this gives an active period of 761 minutes. Omitting four minutes of a session that I did not time in full, the tailed partner took 20 sessions in the nest, ranging in length from 5 to 33 minutes, totalling 314 minutes, and averaging

15.7 minutes. The tailless parent took 16 sessions, ranging from 1 to 49 minutes, totalling 365 minutes, and averaging 22.8 minutes. The birds were absent from the brood chamber (although usually not from the nest) for 23 periods ranging from 1 to 12 minutes, totalling 78 minutes, and averaging 3.4 minutes. One partner or the other was out of sight in the brood chamber, presumably warming the eggs, for 683 out of 761 minutes, or 89.8 percent of the day, which in my experience is unusually high constancy for an ovenbird (Skutch, 1962, table 1).

Although frequently one partner stayed in the brood chamber until the other came to replace it, sometimes it left before relief arrived. If the mate did not promptly take over, the same bird would return to the brood chamber. Thus the interval during which each partner was in charge of the nest, or the interval between change-overs, might include several consecutive sessions of the same bird, with brief intermissions between them. The longest interval between change-overs occurred in the middle of the day, when the normal partner took charge of the nest for 79 minutes, sitting for periods of 20, 32, and 21 minutes, with intermissions of 2 and 4 minutes.

I watched this nest again through the morning of 3 June and the afternoon of the following day. The birds' active period began and ended in the same way as during my earlier observations and extended from 06:11 to 19:01, 770 minutes. In the forenoon the thornbirds incubated more steadfastly than they had done a week earlier, leaving their eggs unattended for only seven minutes, but in the afternoon they were restless, coming frequently to look through their doorway or to climb over the outside of the nest. I counted these interruptions of incubation only when they lasted a minute or more. Treating the two half days as one whole day, the tailed partner took 21 sessions in the brood chamber, ranging from 4 to 42 minutes, totaling 348 minutes, and averaging 16.6 minutes. The tailless mate incubated for 23 intervals, ranging from 3 to 54 minutes, totalling 335 minutes, and averaging 14.6 minutes. Omitting 8 minutes of a recess that I did not time in full, there were 27 intervals of neglect, ranging from 1 to 8 minutes, totaling 79 minutes, and averaging 2.9 minutes. The thornbirds were out of sight in the brood chamber for 683 out of 770 minutes, or 88.7 per cent of the day, which is very nearly the same as their constancy in the preceding week when they sat less restlessly in the afternoon.

Taking the four half days together, the tailed partner took 41 sessions totalling 662 minutes; the tailless partner, 39 sessions totaling 700 minutes. The sessions of the former ranged from 4 to 42 minutes and averaged 16.1 minutes; those of the latter varied from 1 to 54 minutes and averaged 17.9 minutes. The longest interval when neither was in the brood chamber was 12 minutes. The longest interval between change-overs was 79 minutes, when the tailed bird was in charge of the nest. During the next-to-longest interval, 54 minutes, the tailless one was in charge.

Although on the warm, sunny afternoon of 4 June each thornbird left the eggs once, twice, or even thrice during its period in charge of the nest, it rarely left the nest itself. During my whole watch on 3 and 4 June, the nest was unattended only two minutes, while the tailed bird chased a trespassing thornbird. When not inside the brood chamber, the bird in charge stood in the doorway, preening, singing, or simply gazing out. Or it would emerge and go over the nest, pulling up falling sticks and tucking in loose ones, sometimes shifting a piece of material from one place to another, as castle-builders often do.

When coming to take their turns at incubation, or on special trips, the thornbirds often brought additional material to their nest, sometimes a stick, more often fragments of snakeskin, slender petioles or rachises of compound leaves, fine fibers, feathers,

fluffs of cotton from a wild cotton plant, strips of fibrous bark, or some other pliable material. Although I never saw a thornbird carry more than one stick at a time, when bringing finer materials, such as slender rachises, they sometimes carried several pieces together. The soft and flexible materials, and even an occasional stick, were deposited inside the nest, not only in the lowest compartment where the eggs rested, but very often in the middle compartment of this three-chambered nest. A piece of material was sometimes transferred from one chamber to another, and occasionally it was thrown out or carried away from the nest—as I have seen other species of ovenbirds, and also woodcreepers, do. The parents' frequent entry into the middle compartment might have led a casual watcher to conclude that they were breeding there.

Throughout the day, these thornbirds often sang, while standing in their doorway, resting on top of the nest or on a stick that projected from its side, on a neighboring branch, or even inside the nest. The mate might answer from the distance; or they might duet, especially as one replaced the other on the eggs. There was also much twittering. Sometimes the tailless bird twittered while the normal partner sang loudly, leading me to suspect that the former was the female.

Once, when both partners were in front of the nest, neighboring birds of other kinds sounded an alarm, probably because a hawk that I did not see was passing by. Both thornbirds instantly dived into their nest, where they stayed in silence for about two minutes. This was not the only time that I saw a thornbird retire precipitately into its nest when it heard alarm notes. Evidently thornbirds feel safe from aerial predators inside their castles of interlaced sticks.

I watched another nest throughout the forenoon of 17 May, a cool, mostly cloudy morning with intermittent fine drizzles. I did not learn to distinguish by their appearance the two partners who shared incubation, but one rather consistently sang in a deeper voice than the other. Their 13 sessions of incubation ranged from 1 to 59 minutes and averaged 28.9 minutes. The eggs were unattended for only three periods, totalling 10 minutes. The longest interval between change-overs was 66 minutes, during which a single bird sat for 5 minutes, spent 2 minutes on the outside of the nest singing and adjusting sticks, then attended the eggs for 59 minutes until its relief arrived. During 6.5 hours, this pair incubated with a constancy of 97.4 per cent, the highest that I have recorded in an ovenbird. Often the bird coming to take its turn in the nest brought something soft for the lining. Twice during the morning a flock of Groove-billed Anis (*Crotophaga sulcirostris*), coming to eat the arillate seeds of the annonaceous tree that supported the nest, jumped all around the structure, shaking it, and even alighted upon it; but on neither occasion did the incubating thornbird so much as look out.

Even while inside the nest, thornbirds sing back and forth with their mates in the distance. They are reluctant to leave their eggs unattended, and if the mate is tardy in coming to take its turn at incubation, they sing loudly to recall it to its duty. One morning I watched a thornbird, whose partner was evidently neglectful, stand in the doorway of its nest and sing over and over. After many minutes of this loud calling, it seemed to grow hoarse, for its notes became distinctly higher and weaker. Finally, failing to obtain a response, it flew down into the thicket and continued to sing in its altered voice.

All the foregoing observations on incubation were made at nests in which only the incubating pair slept, both of them in the brood chamber, as has been said. At a nest with six grown occupants in which incubation had just begun or was about to begin, some members of the family retired into the brood chamber at nightfall in a manner

which suggested that a parent within was trying to keep them out. One evening a bird who had just entered this nest emerged slowly and apparently reluctantly, as though being driven from within. After clinging a while beside the doorway, it went in again; and again a bird, this one or another, was forced slowly outward. This happened over and over, but finally five or six thornbirds stayed to sleep in the compartment used for breeding. Unfortunately, Troupials broke up this nesting before I could make further observations. At another nest occupied by recently fledged young as well as by older, nonbreeding birds, the parents tried energetically to exclude the rest of the family from the chamber in which they were incubating a second brood, as told in more detail in the section on "The Second Brood."

At one nest the incubation period, measured from the laying of the last egg of a set of three to the hatching of the last nestling, was 16 or 17 days. This may be compared with the incubation periods of certain other ovenbirds: 15–17 days in *Xenops minutus*; about 16 days in *Cinclodes antarcticus*; 17 to 19 days in *Synallaxis* spp.; 20 to 22 days in *Automolus ochrolaemus*; at least 21 days in *Sclerurus guatemalensis* (Skutch, 1969).

THE NESTLINGS

Development.—Thornbirds hatch with pink skin that bears the sparse, gray down typical of passerine nestlings. The interior of the mouth is yellow, rather than black as in the adults. They are 10 days old before their feathers begin to emerge from the sheaths. At the age of 12 days their upper parts are fairly well covered with the juvenal plumage, but their remiges and rectrices are still largely ensheathed. They linger in the nest for another 10 days, not venturing forth until they have attained practically adult size and have fully developed plumage much like that of their parents.

Feeding.—Both parents continue to sleep in the same chamber with the nestlings, as they did with the eggs; and sometimes nonbreeding birds, doubtless their older brothers and sisters, also pass the night with them.

I devoted the morning of 1 July to watching a nest containing three nestlings 10 and 11 days old. At this nest there were no grown birds other than the parents. The first parent left in the dim light at 06:07, and the first meal was brought to the nestlings at 06:15. By 06:30 the young had been fed 11 times by both parents. The number of meals brought each hour, from 06:07 to 12:07, was as follows: 31, 20, 31, 11, 10, 18. In the six hours of the morning, the three nestlings were fed 121 times, or at the rate of 6.7 times per nestling per hour.

On the afternoon of 3 July, we watched this nest from 12:07 until the second parent retired for the night at 19:06. The last meal was brought in the fading light at 18:55. From 12:07 on, the number of meals brought each hour was as follows: 14, 22, 19, 19, 17, 22, 21. In nearly seven hours of the afternoon the nestlings were fed 134 times, or at the rate of 6.5 times per nestling per hour. Taking the records of 1 and 3 July together, the three nestlings received 255 meals in a day of nearly 13 hours.

On 11 July, when the three nestlings were 20 and 21 days old, both parents left the nest at 06:10, and the first meal was brought at 06:22. In successive hours from 06:10

onward, meals were brought as follows: 18, 10, 7, 16, 23, 25. The total of 99 meals in six hours of the forenoon is substantially less than the 121 meals that these nestlings had received in this interval 10 days earlier. Such a reduction in the rate of feeding is not unusual with nestlings which linger in the nest for days after they have passed their period of most rapid growth and become fully feathered.

Although the parents of this brood were difficult to distinguish, they seemed to be taking equal shares in attending their nestlings. As far as I could see, on each visit to the nest they brought only a single article of food, held conspicuously in the tip of the bill. Aside from an occasional round object which may have been a berry but was more probably an egg case of some sort, the nestlings were nourished wholly with insects and other invertebrates which, quite small at first, were rarely large even after the young were feathered. Small brown pupal cases were brought with great frequency. Other items that I recognized were green caterpillars, small grasshoppers, small or middle-sized moths, and rarely a spider. Occasionally the parents of nestlings bring a stick or some lining to the nest instead of food.

The unfinished upper chamber of this recently constructed nest had developed a hole in the rear wall in addition to the doorway in front. When coming with food, the parents nearly always passed through this chamber from back to front, then climbed down the front of the nest to the lower compartment where their nestlings rested. On leaving, they reversed this course, traversing the upper chamber from front to rear before they flew away. I doubt whether this indirect approach to, and departure from, the brood chamber could have deceived any attentive, would-be predator for long; it seemed to be primarily an expression of the thornbirds' predilection for creeping through closed spaces. When carrying away a dropping in their bill, the parents omitted this passage through the upper chamber, as likewise when, as they exceptionally did, they foraged west of the nest instead of to the east or south. The parents promptly removed the shells from which the nestlings hatched, and kept the nest clean at all times.

Brooding.—During the forenoon of 1 July, when the three nestlings were 10 and 11 days old and their plumage was beginning to expand, a parent stayed in the nest, presumably brooding, on 18 occasions, for intervals ranging from 1 to 13 minutes and totalling 70 minutes. The morning was clear except for about an hour when the sky was clouded, and from 11:00 to noon the sun shone hotly. Two days later, when the nestlings were fairly well covered by their rapidly expanding feathers, they were, during seven hours of the afternoon, brooded for 11 periods ranging from 2 to 38 minutes and totalling 170 minutes. Sunshine alternated with showers that were mostly short and light. Even as late as 7 July, when the well-feathered nestlings were 16 and 17 days old, they were, during two hours of a sunny afternoon, brooded for intervals of 8, 11, and 4 minutes. Thereafter, I noticed no more diurnal brooding. By night the parents were probably in close contact with the nestlings as long as they remained in the nest, even if they did not always brood them.

Departure from the nest.—When these nestlings were 18 and 19 days old and no longer brooded by day, the parents, who had formerly gone quite inside to deliver food, sometimes fed with the end of their tail projecting from the doorway. The young birds greeted the arrival of a meal with fine, rapidly repeated, insect-like notes. On the following day, I first heard the nestlings give a weak version of the adult's song. When they were 21 days old, they sometimes advanced far enough into the antechamber to take a meal from a parent who remained outside, in front of the doorway. Occasionally a nestling revealed itself in the entrance while it was fed—hitherto the young had al-

ways remained out of sight. Once one of them came out, turned around, dropped its excreta over the side of the nest, and promptly reentered. Now the young birds often repeated their weak song, and sometimes they uttered an infantine version of the *chip*. I did not hear nestlings twitter.

At this nest, as at another, the nestlings left on the day after that on which I first saw them expose themselves briefly in front of their doorway. Evidently the parents were excited by their imminent departure, for early in the morning of this day I saw one of them give an old feather to a nestling as though it were food. This indigestible offering was apparently not swallowed. Soon after this occurred, a young bird, following a parent who had just delivered a meal, emerged from the chamber and crawled around the side of the nest, but it promptly reversed its course and reentered. I thought that the young would remain inside another day; but by 08:00 one was resting in the top of a neighboring rose-apple tree. A tuft of nestling down still adhering to its head, together with its brighter, fresher plumage, its shorter bill, and the yellow corners of its mouth, helped me to distinguish it from its parents, who were preening nearby. The young bird was about as large as the adults and its tail seemed as long as theirs. Its two nestmates came out later that same day. The two older nestlings had stayed in the nest 22 days, the younger one about 21 days.

Earlier, on 5 June, I watched the departure of another brood, raised in an inaccessible nest into which I had first seen the parents carry food on 15 May. Song floated down from the high nest as I arrived at 06:00. Six grown birds slept in this nest, and although the situation was confused by shifts from chamber to chamber in the morning twilight, it appeared that during the night just passed four or five had lodged in the brood chamber with the two nestlings, while one or two slept in the upper compartment. After leaving the nest, these thornbirds called much and were obviously excited. About the time the last grown bird emerged, two nestlings appeared in the doorway. One crept forth, climbed to the top of the nest, then reentered the brood chamber. Soon some of the adults returned, without food, and stood beside the young in the doorway. The latter came out in front and withdrew into the nest again. Then, at 06:23, with no parental prompting that was evident to me, one fledgling launched forth, and a minute later the other followed. The three-week-old thornbirds flew well and, on descending courses, went direct to trees 75 and 100 feet, respectively, from the nest. The adults sang much after their departure. The fledglings soon vanished amid low, dense vegetation, whence I heard their weak *tsip*'s, although I could no longer see them.

Helpers.—When I found three, and possibly four, thornbirds building together, I confidently expected that I would later see extra birds helping the parents to attend the nestlings. My first opportunity to look for this came at this nest which I found about the time the eggs were laid, when active building had ceased. Since six grown birds slept here, there were four potential helpers. At various times throughout the nestling period, I spent a total of about 12 hours watching this nest, which was high and unfavorably situated for observation. As I could not distinguish the birds individually, the only way that I could prove that three or more were attending the nestlings was to see them bring food together, or almost together, or to see two arrive with food while another was brooding. Although it was soon evident that two adults were feeding the nestlings, they showed no tendency

to come together with food. The most rapid feeding that I recorded at this nest with only two nestlings was 16 times in an hour; after brooding ceased, visits to the nest were brief; and accordingly the likelihood of seeing three attendants at the nest together, even if so many were visiting it, was small. I gathered no evidence that extra birds were helping the parents. One morning, however, a thornbird alighted in a small tree near me with a particle in its bill. Here it delayed, repeating low *chip*'s, before it flew up to the top of the nest. Then, instead of giving what it held to a nestling, it flew down into a thicket still bearing the object. Evidently it was a young bird with budding parental instincts.

Unfortunately, in consequence of various reverses, none of the families in which I had seen more than two birds build succeeded in hatching out nestlings before I left "La Araguata" in late July. I have little doubt that, with more opportunities to watch nests with three or more grown occupants while they held nestlings, I should have found helpers attending the young.

THE FLEDGLINGS

Late in the afternoon of 5 June, I found the two newly emerged fledglings with some grown birds, amid dense bushy growth along a fence between two pastures, where they had gone after leaving the nest early in the morning. Here they remained until, at about 18:25, the parents led one of them up through the branches of a mango tree that grew beside the fence. When they had reached the top of the tree, one of the parents flew across to the nest, entered the brood chamber as though to inspect it, then promptly rejoined the others in the mango tree. Now the fledgling, accompanying its two parents, easily flew to the nest tree, a distance of about 100 feet on a nearly level course. The adults went directly to the nest, but the young bird continued past it and alighted in a fork of the nest tree. From here it immediately flew back to the nest and without perplexity found and entered the lower chamber, where it had been raised. It was then 18:30, and the summits of the western hills were still bathed in golden sunshine, although the valley where I watched lay in shadow.

After the entry of the fledgling, the parents continued to pass back and forth between the brood chamber and the upper chamber. Soon one flew down. A good while later the other parent, evidently hearing the weak calls of the second fledgling, left the nest. Now the second fledgling, who had stayed behind in the bushes, was led to the top of the mango tree, and from here it flew with its parents to the nest tree. It, too, continued past the nest to alight in a crotch, and with only a little more difficulty than the first had experienced, passed from here to the brood chamber, at 18:47. The parents, after a little more going in and out, stayed in the lower chamber

with the young. These two adults alone led the fledglings back to the nest; the other four grown birds who lodged here were still absent. About a quarter of an hour elapsed before they arrived. The first three went directly into the upper chamber, while the last joined the parents and fledglings in the brood chamber, at 19:05. Including the two fledglings, this nest now sheltered eight thornbirds, the largest number that I found lodging in any nest.

Six days later, I again watched this family retire in the evening. As before, the parents and fledglings ascended to the top of the mango tree, whence, at 18:34, a parent and both young flew across to the nest. The young birds promptly entered the lower chamber. Another adult, doubtless the other parent, arrived at the nest a minute later, and both busied themselves arranging sticks before they went inside. At 18:57 two more grown birds arrived. There was so much passing from chamber to chamber that I could not learn in which of them the grown birds slept. The other two grown birds who formerly lodged in this nest failed to appear, and I never, to my knowledge, saw them again. Probably these two represented the parents' first brood of the preceding year, while the two nonbreeding adults who remained were from the second brood. Thus, soon after the latest brood was fledged, the number of occupants of this nest was again reduced to six.

I last saw one of these fledglings receive food from a parent on 17 June, when it had been out of the nest for 12 days and was about 34 days old.

The first days in the open of the fledglings of certain woodpeckers, wrens, and other birds that sleep in dormitories are considerably shorter than those of the adults. They leave the nest late in the morning, retire early in the evening, and are fed by their parents after their return to the nest. But I never saw a thornbird feed a fledgling in the nest after its first flight. From the beginning, the young thornbirds spend a long day in the open. On the day they first left the nest in the algarrobo tree, the three young remained abroad with their parents until 18:45, when the family of five gathered in a small, acacia-like tree close to the nest. A parent flew to the nest, as though to inspect it, and the others followed. All tried to enter together, jamming the passage. Then some came out while others still attempted to push in, causing more confusion. By 18:54, however, all had settled down inside, except one parent, who had gone off carrying a dropping. At 18:59 this adult returned and entered. Thereafter none left, although from time to time one peered through the doorway as daylight waned.

Next morning at 06:04 the parents flew from the nest. They sang much, and the young still inside joined in with their weaker voices. A parent reentered, then left, the brood chamber; but no food was brought. The three fledglings left the nest between 06:13 and 06:15. Much singing greeted their departure. Six days later, the parents and two surviving young left the nest together at 06:10. The third fledgling had fallen victim to a cat.

THE SECOND BROOD

Early in July, the pair of thornbirds whose nestlings I had watched leave on the morning of 5 June gave indications that they would breed again. Late in the forenoon of 5 July, I found two adults and a juvenile on the nest in which the latter had been hatched. The adults were arranging sticks. On the following day, toward noon, two adults and a juvenile were again at the

nest, and one of the former brought a stick. One of them bit the young bird mildly, but the latter did not retreat. On the next morning, 7 July, I saw only the two adults at the nest. By 12 July it was evident that incubation had begun in this inaccessible structure, in the chamber where the first brood had been reared. The members of the pair were taking turns in this compartment, and also bringing new material, most of which was deposited, not here, but in the chamber above it. One of the parents, coming to the nest with a stick, was followed by the two juveniles of the first brood. Three times the adult flew mildly at the young birds; but it did not press the attack, and the youngsters retreated only a few inches. Then they climbed unmolested over the nest.

These parents became increasingly antagonistic to the other birds who continued to sleep in their nest. When I arrived at sunset on 20 July, a juvenile, recognized by its whiter throat and breast, was resting on top of the nest, preening and at times lightly adjusting a stick. A parent was in the lower chamber, incubating, and from time to time coming to the doorway to look out. The other parent brought a long stick. The juvenile, then the adult, flew down.

When, a little later, a thornbird came to the entrance of the brood chamber, as though to retire, the parent who was within darted out and chased it down into the bushes. Then one parent entered the brood chamber and another bird, probably the other parent, went into the upper chamber. As the light grew dim, three more thornbirds arrived and rested on some sticks projecting from the bottom of the nest. Whenever one of these late-comers ascended to the doorway of the brood chamber, the parent sallied forth and attacked it, making it retreat, then returned inside. This happened over and over. As the twilight deepened, the parent in the upper chamber joined its mate in the brood chamber. Then two of the birds who had been waiting at the bottom of the nest cautiously climbed up and entered the upper chamber; whereupon a parent emerged from the brood chamber, ascended to the upper chamber, and forced them out. But they stayed close to the doorway, and when the parent returned to the brood chamber, as it promptly did, they reentered the upper chamber. Then the third of the late arrivals climbed up and joined them. By 19:10, when it was nearly dark, all had settled down, three in the upper chamber and two, doubtless the parents, in the brood chamber.

At break of the following day, I watched this nest again, to check my count. The five sleepers left late, when there was much daylight. While waiting to fly down, one or more of them passed repeatedly from one chamber to the other. They also emerged only to turn around and reenter the same room. Now I detected no discord among the five.

The six thornbirds that in March and April I found sleeping in this and each of two other nests were evidently a mated pair with the young of two broods raised in the preceding nesting season. If the parents habitually show such antagonism to their offspring as I witnessed on the evening of 20 July, how, it may be asked, can a family of six be built up, if no more than three young are raised in a brood? No other thornbirds that I watched displayed such violent enmity to the birds who shared their nest, whether members of their own family or interlopers. Nevertheless, their attempt to exclude the other sleepers was, as we have seen, ineffectual; and the parents' bad temper apparently did not persist until the following morning. Thornbirds who lack nests of their own are amazingly pertinacious in entering the nests of other thornbirds, and this pertinacity is probably greatest when the nest is the familiar abode in which they grew up. Doubtless the antagonism of these parents was associated with the onset of incubation of the second brood and would wane after the eggs hatched, so that at the end of the breeding season they would again dwell peaceably with whatever offspring remained with them.

In Golden-naped Woodpeckers (*Tripsurus chrysauchen*) the young of the single brood that is normally raised continue to lodge in the same hole with their parents until the latter are about to lay again in the following year; and when, as rarely happens, two broods are raised in a season, both remain with their parents, making a family of seven or eight. In these woodpeckers whose family bonds are so strong, an exceptional bird, usually a male, will try to exclude other members of the family from their common dormitory; but his churlish pecks are not always effective in keeping them out (Skutch, 1969). I have even known Southern House Wrens, birds far less sociable than the thornbirds, to persist against strong parental opposition in sleeping in the nest where their mother is rearing a later brood; and if they overcome this opposition, they may minister like parents to their younger siblings. But family groups of House Wrens seem never to endure from one breeding season to the next, as in more sociable birds, such as Golden-naped Woodpeckers, Banded-backed Wrens (*Campylorhynchus zonatus*), and Rufous-fronted Thornbirds they commonly do, despite sporadic outbursts of unsocial behavior.

ENEMIES

One might suppose that the nests of thornbirds, hanging from slender branches, strongly enclosed, and of a complex structure that might confuse predators, would be safer than the nests of most birds. Yet when I left "La Araguata" in late July, only two pairs had succeeded in rearing fledglings, a total of five. Six pairs had certainly lost eggs or nestlings, and several

other pairs, which I visited only infrequently, had probably also lost their broods. One of the six pairs had lost two sets of nestlings. After twice losing their broods from the same nest, this pair built a new nest on a neighboring branch of the same small tree, transferring to it many sticks from the ill-fated older structure. I also found another pair incubating again in the nest from which they lost eggs or nestlings. The pair that included the tailless bird laid again in a new nest in the same tree, after losing one brood of nestlings from the old nest.

One set of eggs and one brood of nestlings were destroyed by Troupials, as told in Part II of this paper. Otherwise, the despoilers of the nests escaped detection. Since, except the nests ruined by the Troupials, the pillaged structures had not been torn open, it seemed evident that the predator was either slender or had a long reach. Probably snakes were the culprits. Although I did not surprise a serpent in the act of pillaging a thornbirds' nest, I had an excellent opportunity to watch the behavior of parents when one threatened their nestlings.

At noon on 9 July, the repeated sharp *chip*'s of alarm of the pair of thornbirds nesting nearest the house drew my attention to a snake over six feet long, a *tigra* (apparently the same species as the Central American *mica*, *Spilotes pullatus*), resting on a low branch of a rose-apple tree whose boughs interlaced with those of the algarrobo tree that held the nest. Seizing a stick, I tried to knock the serpent to the ground; but interfering branches broke the force of the blow, and the reptile climbed beyond reach into the crown of the rose-apple tree. The parent thornbirds continued to hop close around the snake, repeating their alarm notes. When the snake stretched out, they pecked or bit the tail of this creature so much larger than themselves, as I saw clearly through my field glasses. When the serpent coiled up, they did not touch it, as far as I saw, but often they approached within a few inches of the thick part of its body.

For at least an hour and a half, the thornbirds continued to watch and worry the snake. During this interval, I saw them take no food to their nestlings, who remained silent. Finally becoming active, the snake moved toward the nest in the most direct line, which took it into some lower trees between the rose-apple and the nest tree. Here I knocked it to the ground, over which it raced away so swiftly that I could not catch it. The thornbirds continued to look for it in the trees near their nest. After a while, they resumed feeding their nestlings, who flew from the nest three days later.

SUMMARY

Rufous-fronted Thornbirds forage, in pairs or family groups of three to six or eight, through thickets and weedy fields, gathering from the ground most of the insects and other small invertebrates on which they subsist. They disappear beneath the ground litter, and ascend into bushes and vine-tangles to investigate accumulations of dead leaves.

Their vocalizations consist of singing or calling, twittering, and chipping. The loud, ringing song is often delivered as a duet by a mated pair. The birds twitter when close

together, chiefly inside the nest. According to its intensity, chipping expresses mild anxiety or acute alarm.

The territoriality of thornbirds is manifested by boundary disputes that consist chiefly of singing and chasing, and by their often ineffectual efforts to keep intruding thornbirds out of the nest, which at all seasons is used as a dormitory.

The bulky nests of interlaced sticks are built on exposed branches of more or less isolated trees, at heights ranging from about seven to 75 feet. The slender leafy bough chosen for the nest's attachment may be horizontal or even ascending, but more often it droops. Frequently it sinks beneath the structure's growing weight until it hangs vertically.

The nest is built by both members of a pair, sometimes assisted by one or two other thornbirds, evidently their grown offspring of the preceding nesting season. Sticks, up to 21 inches long, are gathered from the ground, attempts to break them from trees being mostly futile. Dropped sticks are often retrieved. The builders try, rather ineffectually, to tear away leaves that interfere with their work. The nest's lining, consisting of almost anything soft or flexible—feathers, snakeskin, vegetable fibers, paper, cellophane, tinfoil, etc.—is added as found, from an early stage in construction to the incubation period, and even later.

The first stage in building usually results in a nest with two enclosed chambers, one above the other. Later, more chambers are added, always at the top, until the nest may contain eight or nine, and become seven feet high. The compartments do not intercommunicate, but each has its own opening to the outside.

The multichambered nest is not an avian apartment house; none of the more than 20 that were investigated was occupied by more than one breeding pair, sometimes with full-grown, nonbreeding offspring. The additional chambers provide lodging for the non-breeding birds while the parents attend eggs or nestlings. Although the complexity of the nest evidently makes it more difficult for predators to locate the eggs or young, many nests are pillaged. The construction of these incongruously large nests evidently represents an exaggeration of the propensity, widespread in the Furnariidae, to build superfluously, as a pastime or outlet for excess energy.

Twenty-two nests were investigated before any young were fledged. In each of three, six grown birds slept; there were two nests with four or five occupants; three nests had three occupants; and 14 were occupied by single pairs. These family groups remained fairly constant from March through May; but in June and July, while breeding was in progress, many nonbreeding birds left the established nests.

Thornbirds who have lost their nests may forcibly intrude into neighbors' nests, in the late twilight many minutes after the resident family has retired. Even after months, the intruders may not become integrated with the family.

As is typical of ground-foragers, the majority of the thornbirds did not begin to breed until the long, severe dry season ended in mid-May. Only a few pairs established on low, moist ground started earlier. The three pure white eggs were laid in the lowest, oldest chamber, except in a nest whose lower portions had been invaded by Piratic Flycatchers. Both parents passed the night with the eggs. When nonbreeding birds were present, they might sleep in the brood chamber—sometimes despite parental opposition—or in an upper chamber.

By day, the parents alternated on the eggs, the two taking nearly equal shares in incubation and attending the eggs for from 89 to 97 per cent of the daytime. Continuous sessions of incubation were rarely as long as an hour and averaged, for different birds, from 16 to 29 minutes. During the incubation period, the parents devoted considerable

time to tucking in loose sticks and keeping their nest in order. They brought much additional lining, some of which was deposited in the brood chamber and some in an unoccupied upper chamber. In one instance, the incubation period was 16 or 17 days.

The nestlings, hatched with sparse down, are fairly well feathered at 12 days but remain in the nest until 21 or 22 days old. Both parents bring them small larval, pupal, and mature insects, rarely a spider, always carrying a single item in the end of the bill. Three nestlings about 12 days old were fed 255 times in a day of nearly 13 hours. Brooding continued, in diminishing amounts, until they were 17 days old.

From the first, fledglings fly strongly and may cover 100 feet on their first attempt. In the evening, they are led back to sleep in the nest with their parents and sometimes also older siblings. They were not fed in the nest after their first flight.

A pair whose young left the nest on 5 June were incubating a second brood by 12 July. They now tried hard to exclude their grown offspring from the nest at night-fall, but the latter persisted in entering.

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