

THE BREEDING BIOLOGY OF THE RED-FACED WARBLER  
(Cardellina rubrifrons)

by

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## ABSTRACT

The Red-faced Warbler (Cardellina rubifrons) is a common summer resident in the mountains of southern Arizona. The breeding biology, habitat, and behavior are described and discussed.

The female Red-faced Warbler builds the nest and incubates the eggs unaided by the male. The incubation period is 15 to 17 days. The young remain in the nest for 13 days. The total time from egg laying to fledgling is 7 to 10 days longer than the corresponding period of warblers breeding north of Arizona. The longer incubation and nesting periods of the Red-faced Warbler are considered a major factor in limiting northward expansion of its range.

On the basis of the morphological and behavioral features I have studied, I feel that Cardellina is related to the genera Wilsonia, Basileuterus and Ergaticus. The shape of the bill is intermediate between Wilsonia and Basileuterus. Cardellina, Ergaticus, and Basileuterus have long incubation and nestling periods, lack sexual dimorphism, and seasonal plumage variation, and obtain the adult plumage shortly after the young leave the nest. Both Cardellina and Wilsonia build an open cup nest on

the ground, lay usually four eggs in a clutch, fly-catch in the air, flick their tail sideways and utter similar calls. Male Red-faced Warblers often move up to 200 yards away from their nest site. In doing so they move through areas occupied by several other pairs of warblers and do so without conflicts.

## INTRODUCTION

Jacob Post Giraud, described the first specimen of the Red-faced Warbler known to science. He called it the Red-fronted Flycatcher (Musicapa rubifrons). This and 15 other birds were described in his publication of "Sixteen New Birds From Texas", in the annals of the New York Lyceum of Natural History in 1841 (Stone, 1919). The birds were supposedly collected in Texas in 1838, however, neither the collector nor the locality is definitely known. Several of the 16 species have never been recorded in the United States, but all are common in the mountains of western Mexico. The actual locality is probably in southern Chihuahua. Giraud's holotype is presently located in the United States National Museum (Deignan, 1961:548).

Ridgway (1902:721) provides a synonymy of the Red-faced Warbler. Various investigators between 1850 and 1860 placed the bird in Cardellina, Basileuterus, or Setophaga. Du Bus (Ridgway, 1902) in 1850 described the bird as new to science and called it Cardellina amicta. The bird is now properly recognized as Cardellina rubifrons (Giraud).

Henshaw (1875) was the first person to definitely take Cardellina rubrifrons, north of Mexico. Mr. Henshaw collected birds in Arizona, at Camp Apache and on Mount Graham. At Camp Apache in July 1873, he first found the birds by identifying the call of the female feeding her young. In August he found the Red-faced Warbler to be common on Mount Graham.

Mearns (1890) recorded the first nest and eggs of Cardellina. This nest was located below the San Francisco Mountains on the 19th of June in 1886. Price (1888) found a set of eggs on May 31, 1888, in the Huachuca Mountains and was the first to describe them.

Since this time, the Red-faced Warbler has been observed and their eggs have been collected by several workers in Arizona and New Mexico, but no one has published anything more than a casual observation on their behavior. Bent (1953) in his Life Histories of North American Wood Warblers, states that no information on the incubation of eggs or care and development of the young is available.

Observations on the breeding biology, ecology, and behavior of Cardellina are presented here. I speculate on the factors that restrict its range or help adapt it to its environment, and I comment on its intergeneric relationships. This thesis is the representation of five months of study in the Santa Catalina Mountains of southern Arizona.

## MATERIALS AND METHODS

Field work on this study, began in March 1965. I made trips to the Santa Catalina Mountains every third day until the arrival of the Red-faced Warbler on April 10. I then established a study area in Marshall Gulch, which is located two miles below the town of Summerhaven by road. I spent 51 days in the period of April 19 to June 26 in the study area. I made observations of the closely related Canada Warbler (Wilsonia canadensis), in York County, New Brunswick, Canada, between July 1 and 12, and similar observations of the Hooded Warbler (Wilsonia citrina) in Fairfield, Connecticut from July 14 to 20. My studies of the two species of Wilsonia are not recorded here, but I do make use of them in my discussions.

Birds were observed with 7 X 50 binoculars. I had some difficulty banding the Red-faced Warblers, and the Japanese mist nets did not provide a satisfactory means of capturing them. The birds flew up into the trees when I attempted to drive them into the nets. I was able to capture and subsequently band three females with color bands and United States Fish and Wildlife Service aluminum bands by placing the mist net in front of the nest and flushing the

birds off of the nest from behind. Three sets of young birds (12 individuals) were color banded before they left the nest.

The Red-faced Warblers were numbered by pairs for convenience. I built blinds of canvas within five feet of each of four nests.

The first egg laid in each clutch was marked by one dot, made with a Rapidograph pen, the second egg with two dots, etc. I weighed the young birds with an Ohaus Triple-Beam Balance, accurate to about 0.2 grams.

## HABITAT

Marshall Gulch, is an east-west ravine about a mile and a half long, with a permanent stream flowing into the Upper Sabino drainage. The elevation ranges from 7,500 feet at the convergence of the gulch with the main Sabino Canyon stream at the east end, to 8,000 feet on the west. The sides of the ravine rise steeply to about 8,000 feet in the south to 8,500 feet on the north. The rise is sharp enough to make walking difficult except on the one path on the south facing slope. The valley floor varies in width from about 15 feet to 60 feet and gradually slopes eastward. In several places the stream cuts through rock leaving steep cliffs up to 40 feet high. The stream meanders through tiny meadows, forms small pools and runs swiftly over small rocky areas. It varies in size from a width of one to eight feet and has a bed of rock with occasional areas of gravel. Several small stream beds run down each slope to join the main stream in Marshall Gulch. These tributaries are dry except during the heavy summer rains and spring thaws.

The sheltered steep walls help to maintain low temperatures in the gulch. Snow banks did not completely disappear until the middle of May. On one occasion in

June, a small amount of snow fell but it never accumulated. It is an impressive sight on an early morning in May, to watch a male Broadtailed Hummingbird (Selasphorus platycercus) alight on the ice and take a bath in the chilling stream.

I casually recorded air temperatures throughout the spring season, with a mercury thermometer. In May the temperatures averaged 65° in the day and 35° at night. In June the daytime temperature rose to the low 80's and fell to the low 50's at night.

Two distinct Life-zones are represented in the gulch. On the south facing slope the dominant tree is the ponderosa pine (Pinus ponderosa), which is characteristic of Merriam's Transition Life-zone. Additional trees present are; white pine (Pinus ayacahuite), Douglas fir (Pseudotsuga menziesi), and Gambel oak (Quercus gambeli). The ground cover is made up almost entirely of pine needles, muhly grass (Muhlenbergia virescens) and small stands of netleaf oak (Quercus reticulata), which is a shrub at this elevation. (see Figure 1).

The north facing slope is characteristic of the Canadian Life-zone of southern Arizona (see Figure 2). The dominant trees are Douglas fir, alpine fir (Abies lasiocarpa), and white fir (Abies concolor). Deciduous trees present are; bit-toothed maple (Acer grandidentatum),

box elder (Acer negundo), western chokecherry (Prunus serotina), quaking aspen (Populus tremuloides), alder (Alnus oblongifolia), and mulberry (Morus microphylla).

The understory is relatively open, consisting of young trees of previously mentioned species. The ground is moist and yielded perennial grasses and flowers in shaded areas. Large areas of deciduous leaf litter accumulated at the bottom of slopes, forming suitable nesting habitat for the Whip-poor-wills (Caprimulgus vociferus) and Turkey (Meleagris gallopavo).

Figure 1. South facing slope in Marshall Gulch study area.

Figure 2. North facing slope in Marshall Gulch study area.



(Figure 1)



(Figure 2)

## ARRIVAL AND PAIR FORMATION

The Red-faced Warbler is the last warbler to arrive on its breeding grounds in Arizona. The earliest record is April 9, in the Santa Rita Mountains (Phillips, Marshall and Monson, 1964).

I searched the Santa Catalina Mountains thoroughly at intervals of three days for early arrivals. An ornithology class from the University of Arizona found the first birds on April 10. They were in a flock of migratory warblers in the Upper Bear Canyon picnic area (6,200 feet). On April 11, 12, 14, and 15, I could not find any Red-faced Warblers, but on April 19 the birds appeared on their breeding grounds. The first bird found on this day was in a small canyon along the Mount Lemmon Highway, one mile below the turn-off to Rose Canyon Lake. The small canyon has a few white pine trees, but ponderosa pine and silver-leaved oak are the dominant trees. I located the bird by its song, but an hour's searching failed to reveal any other Red-faced Warblers.

Upon my arrival in Marshall Gulch, later in the morning of April 19, the presence of the warbler was

apparent by the singing of three males. The first male that I observed, was singing and hunting for insects in a small ponderosa pine. Following close behind him was a female. The male Red-faced Warbler moved from tree to tree at a height of five feet.

Three times in one hour of careful observation the male pursued the female. Each chase began when the female came too close to the male. While chasing the female the male emitted a distinct call, a dee-dee, which is similar to the call made by the young bird. Each chase lasted from 35 to 50 seconds, and consisted of "blind" flying under the lower pine branches. The birds flew within a foot of me as the female dodged the tree trunks in an effort to escape the male. But copulation did not take place, and at the end of the chases, the male would stop, "catch his breath", and continue feeding and singing. The female would resume feeding and again follow the male.

By April 22, six of seven males in Marshall Gulch were followed by females. The same behavior of chasing and following was observed in six pairs. On April 24, the seventh male was also accompanied by a female. All birds seemed to stay close to the ground when feeding. Occasionally the females would drop down in the dead leaves, accumulated at the bases of the stands of netleaf oaks, presumably in search of a nesting site. The males

sometimes followed, but in a fashion that appeared to be in pursuit of the female.

Apparently by April 24 all birds were back from Mexico and on their breeding grounds. The study area was believed to contain seven pairs of Red-faced Warblers at this point.

## VOCALIZATIONS

The song of the male Red-faced Warbler has been described as, "a tink a tink a tink tsee tsee tswée tswéep" (Taylor, in Bent, 1953), and this interpretation seems appropriate to me. The male sings persistently on the breeding grounds. In normal warbler fashion it delivers the song as it feeds. The intervals at which the song is given appear to differ from male to male. The song lasts about 1.5 seconds and is delivered at intervals averaging 8.7 seconds for male 1, and 15.4 seconds for male 2 (see Table 1). Variations in the song of an individual are generally in the length and not the pattern.

There are predawn and dusk singing periods, in which the male sings constantly for ten to fifteen minutes from his roost.

In general the birds sang more often in the morning than in the afternoon and less frequently in August than in May.

Other calls of the males were a dee-dee emitted during attempts of copulation and a chip used in scolding, warning, and in pair recognition. This chip was the same as that given constantly by the female. It is distinct from all notes of other members of the Family Parulidae

nesting in the Santa Catalina Mountains, and served as a mean of identifying the Red-faced Warbler. The chip is identical to the call of the Wilson's Warbler (Wilsonia pusilla), and during migration period I could not distinguish between these two species by call alone.

Young Red-faced Warblers cried a dee-dee in anticipation of food from the adults. A psst note is uttered by the male when in the presence of the female and may serve to identify the male to the female.

Table 1

Intervals in seconds between songs of three different male Red-faced Warblers on May 1. Data recorded in late morning.

	Male 1	Male 2	Male 3
	9	6	11
	11	6	12
	8	13	7
	9	12	12
	10	14	11
	13	33	13
	12	27	15
	6	26	21
	12	13	14
	15	15	10
	11	15	21
	13	28	9
	7	12	10
	9	15	6
	6	16	13
	9	15	7
	10	17	
	7		
	7		
	10		
MEAN	<u>8.7</u>	<u>15.4</u>	<u>12.0</u>

## FORAGING BEHAVIOR

I recorded observations of methods of feeding utilized by Red-faced Warblers and the heights at which they foraged throughout the course of this study. Data were not used if an individual was not observed feeding five times or more in succession. A total of 296 recorded individual feedings were evaluated in obtaining the following results.

Feeding is performed in three ways; flycatching, gleaning, and picking insects off of branches. Flycatching is performed most expertly and is the method most frequently used. The Red-faced Warbler often sits vertically and watches for flying insects. After finding a prospective meal, the bird flies out to catch the insect, which it does with an audible "snap" of the mandibles. The warbler may return to the same perch, or more commonly return to the closest available limb. On a morning when feeding is quite vigorous, Red-faced Warblers move up and down the trees catching insects on the wing. At this time the birds never remain more than a split second at each perch. If flying insects are not immediately seen, the bird flies out and gleans at the ends of a branch or a leaf. Gleaning is accomplished on the wing and is similar to that

of hummingbirds. Small insects are plucked from pine needles or the underside of leaves in this manner.

Insects are also picked up along the branches, in between flycatching flights. Feeding in this manner appears to be done by chance as there is only a minimum of searching in these areas. This type of feeding is well developed in the other genera of warblers (Dendroica and Vermivora) found in the study area.

My records show that 49% of the insects caught were obtained by flycatching, 30% by gleaning and 20% by picking insects from branches.

To determine the average height of feeding, I divided the forest trees into 15 foot levels. The Red-faced Warblers were not recorded feeding above 45 feet, consequently three levels were involved. For 311 recorded feedings, 66% were in the lower 15 foot level, 27% in the 16 to 30 foot level, and 7% in the 30 to 45 foot level. Most trees in the study area were 60 feet or higher.

## INTRASPECIFIC BEHAVIOR

There is no sexual dimorphism in Cardellina, but the sexes can usually be separated in the field by their behavior. The female appears to move in a deliberate fashion, compared with the "flitty" movements of the male. Females usually perch in a horizontal position, while the males perch vertically. The females use the chip call quite frequently. The constant singing of the male Red-faced Warbler is the most useful sex determining characteristic in the field.

Conflicts arose between males only in the presence of a female. On May 5, I observed two males feeding and singing in the same tree. Both birds worked about ten feet apart for about three minutes. A female arrived, emitted her chip call and one male flew to her uttering his dee-dee courtship call. The second male promptly flew at and chased the courting male, and the first male flew away. The female appeared uninterested in the dispute between the males.

While watching pair 4 building its nest on May 18, male 5 appeared close to the nest site. Male 4 was feeding about 20 yards away and paid no attention to the singing of male 5. Female 4 flew to a branch near her nest,

with a pine needle in her bill. Her chip attracted male 5, which proceeded to court her. Male 4 arrived and a very brief fight ensued, and male 5 scurried away with male 4 in pursuit.

A similar dispute took place on May 19 between male 2 and male 7. Female 2 was building her nest while male 2 was feeding and singing about 20 feet away. Female 2 flew to a branch and gave her chip call, which attracted male 7. Male 7 flew to female 2 emitting his dee-dee cry. Male 2 promptly flew to female 2 and threatened male 7. Male 7 flew off with male 2 close behind. In the threatening posture, the male holds his head level with his body or below it, crouches with his body close to the perch, holds his wings slightly drooped, and spreads his tail directly behind and parallel to his body. At the proper moment, the male launches himself with great speed toward his antagonist.

Conflicts were not restricted to the nest area. On May 25, I observed two males drinking and feeding, without apparent friction, within five feet of one another. I presumed that the birds were from pairs 6 and 8. After five minutes without any conflict, a female flew in to bathe in the stream. A male proceeded to fly down to her, this action resulted in a brief fight between the males and the departure of male 8. The female concentrated on

bathing and was apparently uninterested in the combat of the males. Male 6 sang a few times and then joined the female along the stream.

The defense of a territory by singing does not appear to be a significantly important trait of the Red-faced Warbler. Males sing almost constantly, but allow other singing males to move quite freely through their areas. The singing of one male definitely stimulates the surrounding males to sing. This sometimes appears to start a chain reaction, reminding me of frogs and toads which call in their breeding ponds.

Early in the season the males appear to form small singing groups. On April 22 five males were singing in an area of about 100 yards in diameter. The males apparently congregated in a singing contest to attract the females in the area. I saw no actual conflicts between males on this instance.

On May 1, a lone male was singing quite frequently in an area adjacent to the edge of the area occupied by pairs 1 and 2. His singing resulted in a singing contest between three males. The lone male had a lighter red face and appeared to be a young bird. With the arrival of a female, fights took place between male 1 and the lone male, and male 2 and the lone male. The lone male was forced to move up the hillside away from the areas occupied by

pairs 1 and 2. On the next day the lone male had found a mate and I noted no further conflicts between the males.

The wanderings of the Red-faced Warblers are not restricted by other individuals. It is not uncommon to watch an individual leave a tree and fly 100 yards down stream, or across to the opposite slope. In such a flight the individual has often passed by two or even three nests of other Red-faced Warblers. Return routes may be in an arc, traversing two or three different nesting areas of other pairs of the warblers. One observation of this phenomenon took place on May 28. I was sitting on a rock overlooking the stream and areas occupied by pairs 6 and 7. The rock is situated in the area of pair 8. Behind me males 4 and 5 were singing. Male 5 was singing from a ponderosa pine in his area. He then flew about 30 yards southeast to a fir tree in the area of pair 6. Male 6 was singing about 30 feet away and paid little attention to the singing of male 5. Male 5 then flew east along the stream to a maple tree, in the area of pair 7. Male 7 was singing in a fir tree about 20 yards away and he also paid little attention to male 5. Male 5 fed and drank here and then slowly worked his way back from tree to tree through the areas occupied by pairs 3, 8, and 4. No conflicts were observed in this 25 minute trip, and yet male 5 had just moved through the areas occupied by five other pairs of Red-faced Warblers!

Conflicts were not observed between females.

Females 1 and 2 were often observed within 15 feet of one another. Females 6 and 7 occasionally gathered nesting materials within ten feet of one another. Females 4 and 5 fed their young within 30 feet of one another on June 20. This resulted in a dispute between corresponding males when male 5 approached female 4.

Most conflicts took place at the nest site. If I flushed a female from her nest, her scolding brought all surrounding male Red-faced Warblers. The proper male, upon arrival, would participate in defending the nest and then chase away the foreign males. Males that came to investigate the commotion produced by the scolding female, did not participate in the defense of the nest, but pursued the female.

## NEST CONSTRUCTION

### Nest 1

On May 1, at 7:00 a.m., I saw the female of pair 1 with a pine needle in her bill. Her characteristic chip, helped to draw my attention to her. She flew 20 feet east and dropped down in a stand of netleaf oak. In a few seconds she left. My investigation revealed a small hollow in the leaves exposing bare ground with 14 pine needles arranged in a criss-cross fashion, on the down slope side of the hollow (Front). I concluded from this evidence that she had begun construction earlier in the morning and not on the day before. This pair was the first to begin building a nest in the study area. They were nesting in the warmest and most sunlit area in Marshall Gulch.

On the first day (8:00 to 9:00 a.m.) of construction, female 1 placed 12 pine needles and spent 288 seconds arranging them. In one hour (10:00 to 11:00 a.m.) on the second day, the female gathered 15 pieces of grass and she spent 468 seconds arranging them in the nest. On the third day, 17 pieces of grass and fibers were brought in one hour (6:00 to 7:00 a.m.), and 372 seconds were spent in the nest.

The male visited the nest about three times an hour and copulated each time with the female. This seemed to stimulate the female in her building duties. The male was usually close by feeding and singing and I could observe both birds during the time that the female was constructing the nest. This nest was completed by May 7. An hour of observation on the afternoon of May 8 revealed no building activity. Neither the male, nor the female came near the nest in this hour. The first egg was deposited on May 12.

#### Nest 2

By May 3, pair 2 and 6, had begun nest construction. On the morning of May 3, pair 2 was feeding in a small ravine above the upper trail. The female flew down to the ground and picked up a pine needle. She then flew to a small patch of netleaf oak and gave her chip call a few times before dropping into the base of the patch. The nest contained fewer than ten pine needles. The amount of material, indicated that she had started the nest about one hour earlier. In the next hour she brought in 13 articles to the nest. Nesting material was always collected away from the nest site. On one such trip the female disappeared into a large stand of netleaf oak, about 50 feet east of the nest site. She reappeared and perched in

the stand of oak and had a leaf in her bill. After a few seconds of apparent debate, female 2 released the leaf and dropped back down to the ground. She reappeared 30 seconds later without any nesting material in her bill, and flew 45 feet down the slope. In a few seconds she returned to the same stand of oak with a piece of bark in her bill. I watched this female bring material to her new nesting site for another hour. From these observations I concluded that she had selected a second nest site during the process of gathering material for her first nest. She continued to build this second nest for the next five days, but suddenly stopped on May 8, before the nest was completely lined.

She did not start a third nest until May 18. This nest was situated under a clump of muhly grass about 100 feet down slope from her second nest. The third nest took five days to complete and contained one egg on the morning of May 23.

### Nest 3.

On the morning of May 5, I found female 3 carrying pine needles. She flew to a lower branch of a Douglas fir, chipped, and dropped down into a patch of netleaf oak. My investigation of the nest revealed that she had just begun building.

May 14 (nine days later), the female of pair 3 was still building but not as steadily as on previous days. On May 15 the female laid the first egg.

#### Nest 4

Pair 4 frequented an area close to the upper trail and adjacent to pair 5. Copulation on the ground was observed on May 5. Both birds were feeding low in a large patch of netleaf oak when the female dropped down to the ground. The male followed, copulation took place, and then the male flew up and continued singing.

For the next 15 days the birds were watched for almost two hours every morning, since it was possible to watch pairs 4, 5, and 6 at one time. I thought that pair 4 was building a nest on the hillside which was entirely covered with silverleafed oak and netleaf oak. It was not until May 18, that nest construction was observed. I suspect that this may have been the second nest of female 4 because she was observed carrying materials earlier, and apparently she had been depositing them in the dense oak stand, but no nest was found.

The nest found on May 18 was partially completed. It was located on the east side of a ravine, adjacent to the hillside cluster of oaks that the pair regularly frequented. It was placed in a small patch of netleaf oak. The first egg was laid on May 20.

## Nest 5

Pair 5 occupied an area close to pairs 4 and 6. Nest building began on May 5. The nest was placed in a small patch of netleaf oak, below a Douglas fir. On May 5, the female carried pine needles and leaves to the nest site. On May 18, the nest was completed and on May 19 the first egg was deposited.

## Nest 6

From a vantage point above pair 6, at 3:30 p.m., on May 3, I clearly viewed the process of nest site selection. The pair foraged in a maple tree at the edge of the stream. The male was flycatching from an outer limb, while the female was catching insects about the middle of the tree. The female flew down to the roots of the maple, which were exposed by the stream and undercutting a two foot bank along the base of the tree. She proceeded to investigate the roots on the west side of the tree. Here she found a small crevice and she investigated it by removing a few leaves with her bill. After a few seconds of apparent debate, she flitted to the east side of the tree. As before, she investigated possible nest sites by removing leaves and debris with her bill. She apparently found nothing suitable and soon she flew east along the bank to a young fir tree. The male flew

down to her, emitting his dee-dee cry and then in a brief moment copulation had occurred. The male then flew back to the maple tree and continued to feed. The female examined a few more potential sites at the edge of the bank, until she found a hollow beneath the grass that was growing from the top of the bank. Again she removed leaves and debris with her bill, forming a bare spot which was hidden by the grass from above. She tugged on grass stems that were in her way and flew out with them in her bill in successful attempts to break them. Leaves were picked up with the bill and carried out and then dropped. After four minutes she flew out, chipped, and flew about 20 yards east. She returned to the small fir tree with a leaf in her bill. She reached the hollow, once again gave her chip, and flew in. In the next half hour she brought four leaves to the site, chipping each time before she entered. All material was gathered away from the nest site.

The nest was completed on May 16. On May 18 it was found partially destroyed. No eggs were deposited on May 17, but it is probable that the first was laid on the 18th and a predator found it. It is unlikely that the female did not lay an egg because an empty nest would not have attracted a predator on May 18.

## Nest 7

The nest of pair 7 was first located on May 9. It was situated under the edge of the stream bank and covered with grass, in a fashion similar to nest 6. The nest was approximately three days old when discovered. Building ceased on May 16 and the first egg was deposited on May 18.

Female 7 usually flew upstream to obtain her nesting materials. Female 6 usually flew downstream to obtain her nesting materials. Both birds picked up materials from the same general area and often at the same time. On occasion female 6 was observed collecting nest materials within ten feet of nest 7, and female 7 was collecting nest materials within 12 feet of nest 6. Neither bird was observed collecting nest materials within 20 feet of her own nest.

## Nest 8

I did not realize the presence of pair 8 until the afternoon of May 22. In walking from nest 4 to nest 3, I varied from my normal route and quite by accident I flushed a female Red-faced Warbler from a tuft of muhly grass. It was immediately evident by her distress display that she had left a nest. The nest contained four eggs and was carefully hidden from above by the grass. I carefully and systematically searched the study area during the next three days but discovered no other pairs.

Table 2.

Nest site locations of the Red-faced Warbler  
(Cardellina rubrifrons).

---

Pairs	Nest Site
1	netleaf oak
2a	netleaf oak
2b	muhly grass
3	netleaf oak
4	netleaf oak
5	netleaf oak
6a	stream bank
6b	base of small tree trunk
7a	stream bank
7b	roots of trees
7c	base of small tree trunk
8	muhly grass

---

## EGG LAYING

Eggs are deposited one a day between 5:00 and 7:00 a.m. Incubation does not begin until a full clutch has been laid.

On May 12 nest 1 contained one egg at 9:00 a.m. The nest was checked every hour until 10:00 p.m. and the female did not return to the nest. The egg was marked with one dot at the larger end with a Rapidograph pen. Each successive egg was marked with a number of dots corresponding to its sequence in the clutch.

On May 13 the second egg was laid at 6:20 a.m. The pair had roosted together at the top of a large alpine fir tree. At 4:47 a.m. the male began singing from the roost. By 5:15 a.m. the pair had moved down to their normal feeding level. At 6:15 a.m. the female appeared at the nest, chipped, and flew into the nest. By 6:45 she had left and a second egg had been deposited. I marked the egg with two dots, and watched the nest the rest of the morning, but the female did not return.

On the morning of May 14 the third egg was deposited. The female had again roosted with the male at the top of the same fir tree. She appeared at the nest at 6:55 a.m. on the next morning. At 7:28 a.m. she left

and the fourth egg had been laid. I presumed that incubation would begin and I watched the nest until 9:00 a.m. The female had not returned so I checked the nest every hour and observed it for a minimum of 15 minutes at a time. The female appeared at 4:12 p.m. and began incubation.

Pair 2 finally succeeded in finishing a nest on May 23. On May 24 the first egg was deposited before 9:20 a.m. The second egg was present at 6:35 a.m. on May 25. The third egg by 6:35 a.m. on May 26. The nest was destroyed on the afternoon of May 26.

Female 3 laid her first egg before 9:40 a.m. on May 16. The egg was marked and the nest was observed but the female did not return. On May 18 the third egg was laid before 6:45 a.m. At 6:20 a.m. on May 19 the female flushed from the nest upon my approach to check the nest site. She returned at 6:33 and left at 7:04 after laying the fourth egg. I marked each of these eggs.

Nest 4 was completed on May 19 and the first egg was deposited before 5:45 a.m. on May 20th. The second egg was laid on May 21, the third on May 22, and the fourth on May 23. Incubation began about 5:00 p.m. on May 23.

Pairs 5, 6, and 7, followed the same procedure of laying one egg a day.

The eggs were exposed to environmental conditions for as long as three and one-half days, during which time the night temperatures dropped as low as 28° F. On June 4, ice formed on the slower parts of the stream, while the eggs of pair 7 were exposed. Ice formed on May 18 and 19, when the eggs of pairs 3, 5, and 7, were exposed to ambient temperatures.

## INCUBATION

Incubation began the afternoon following the laying of the fourth egg. Hatching of the eggs occurred in 15 to 17 days in three pairs that I closely observed. In typical warbler fashion, the female was a very "nervous" sitter. She would change positions about every five minutes, stand up, and move the eggs with her bill, and never hesitate to flit off of the nest in pursuit of an insect that ventured too near. Close observation of nests 3, 4, and 7 revealed that only the females incubated. Males often visited the nest, usually following the female as she returned from a feeding journey. I did not observe the male feeding the female while she was at the nest, until after the hatching of the eggs. Visits to the nest by the male before the hatching of the eggs appeared to be in response to the male's urge to copulate.

Females remained off of the nest longer in the morning than in the afternoon. Sometimes as long as 40 minutes were spent feeding in the morning, as opposed to 10 minute trips in the afternoon.

The eggs hatched within a period of seven hours. Events in the nest of pair 3, on June 4, will illustrate the details of the hatching act. At 8:00 a.m. the egg

laid on the second day was cracked. By 9:55 the young bird was completely free of its egg shell, and the egg laid on the third day was cracked. The female returned and fed regurgitated insects to the first young bird and then ate the egg shell. The male, at this time, was a good distance up the slope singing. As he came close to the nest the female flew off and chipped. The male proceeded to catch an insect and bring it to the nest. He then "chewed" it with his bill and fed pieces to the young bird. The female came back after the male had left and continued to incubate. By 11:03 two young had hatched. Upon inspection of the nest at 1:30 p.m. three young had hatched and the egg laid on the fourth day was cracked. At 2:55 p.m. the fourth young was almost free of the egg shell. Escape from the egg shell was performed by stretching the body, and the limbs, accompanied by opening the bill. The young birds seemed to be doing a breast stroke in their efforts to break the egg shell.

The egg tooth was small and white. The young birds were orange skinned with a small amount of down on the head and the middle of the back. All four young were hatched by 3:10 p.m. The female returned to the nest and ate the last egg shell, and then resumed brooding at 3:15 p.m.

Table 3

Egg-laying and hatching dates in three nests of  
C. rubrifrons.

Egg	Date of laying	Day incubation began	Date of hatching	Days from laying to hatching	Incubation period
Nest 3					
1	16 May	19 May	4 June	20	17
2	17 May	19 May	4 June	19	17
3	18 May	19 May	4 June	18	17
4	19 May	19 May	4 June	17	17
Nest 4					
1	20 May	23 May	6 June	18	15
2	21 May	23 May	6 June	17	15
3	22 May	23 May	6 June	16	15
4	23 May	23 May	6 June	15	15
Nest 6					
1	26 May	29 May	13 June	19	16
2	27 May	29 May	13 June	18	16
3	28 May	29 May	13 June	17	16
4	29 May	29 May	13 June	16	16

## PREDATION

Of the eight pairs studied, only pairs 3 and 4 raised a family of young from their first nesting. Five of the remaining six pairs had their eggs stolen. Pair 8 lost their four young when they were only four days old.

The six pairs built new nests and laid another set of eggs. After loss of a clutch of eggs, a period of five to seven days elapsed before construction of the second nest began. Instead of an eight to ten day construction period that was utilized in the construction of the first nest, a five to six day construction period was observed in three cases of the second nest construction. The second nest may be from 40 to 200 feet from the first nest site (see Figure 3). In all three pairs, the first egg was laid the morning after the completion of the second nest.

Five of the six pairs that built a second nest successfully raised a clutch of young. Pair 7 had their second clutch stolen on June 14. On June 18 I found a female building a nest 135 feet northwest of pair 7's second nest site. This female was not banded; the female of pair 7 was banded. The male copulating with her was

the male of pair 7; I could identify this bird by the lack of two tail feathers which he had lost before the completion of the second nest.

The banded female 7 was not found after her nest had been destroyed. This nest was destroyed at night presumably by a skunk and it is possible that the female was devoured by the skunk. I searched for female 7 from June 15 to 23, but could not find her.

I believe that the Steller's Jay (Cyanocitta stelleri), and the Striped Skunk (Mephitis mephitis) are the two main predators in the study area. Two types of nest destruction occurred. In some cases the eggs disappeared but the nest was undamaged; I believe the jays were responsible. Other nests were torn apart and the eggs taken; probably the skunks did this.

I observed Steller's Jays watching the Red-faced Warblers from inconspicuous perches. The female Red-faced Warbler's habit of perching directly outside of her nest, chipping and then flying into the nest makes the eggs vulnerable to the alertness of the jays. Jays successfully learned how to withdraw food from paper bags after they had watched me eating from the bags. I believe that they may have learned to raid nests by watching small birds entering their own nests.

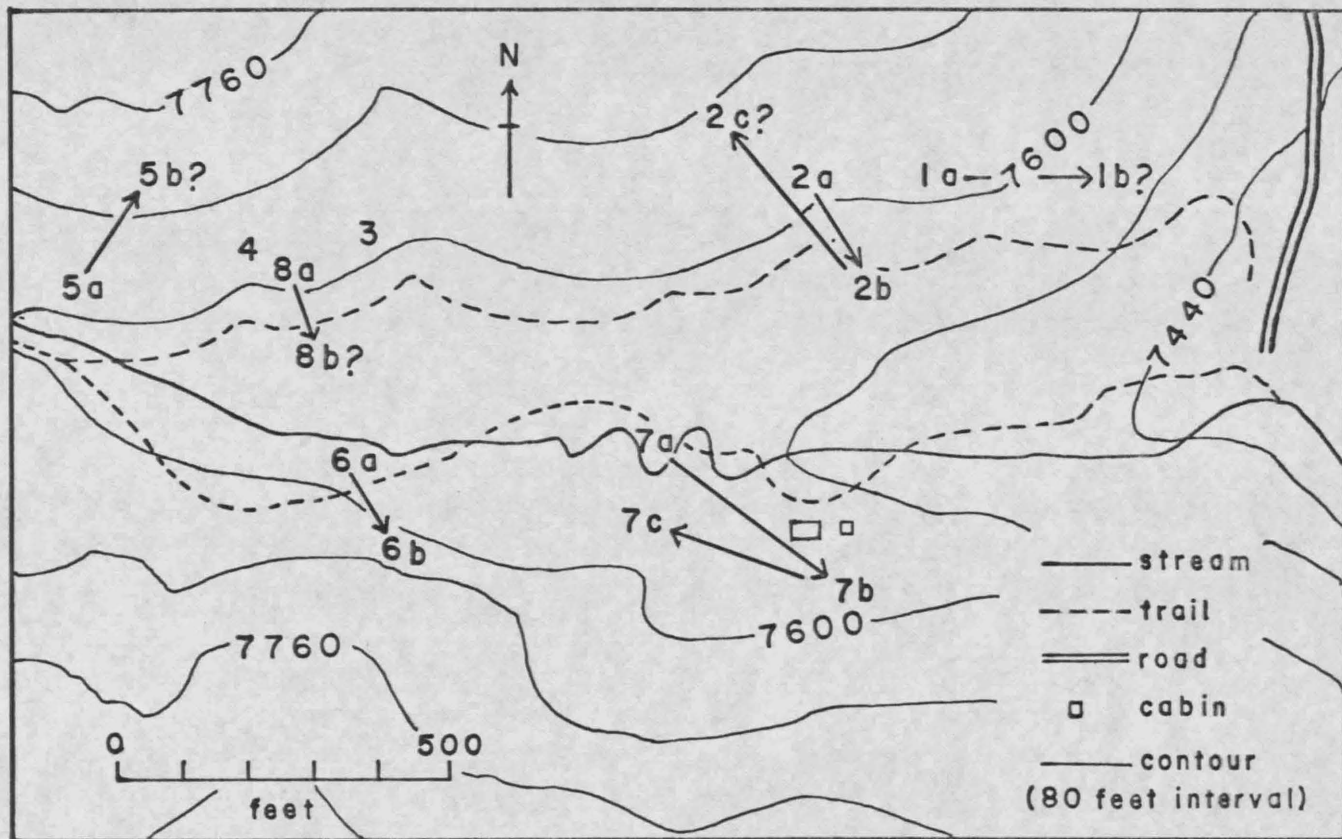
Skunks on the other hand, probably located the

nest sites quite by accident. It is the habit of the skunk to investigate crevices at the base of trees and under tufts of grass in their search for insects. These are the places that the Red-faced Warblers use for nesting. I attribute three cases of nest destruction to the skunk, and four to the jay.

Factors making the second nesting of the Red-faced Warbler more successful are; the heavier growth of the understory by late May, and the fact that the jays were occupied with nesting chores of their own and probably did not have the time to search successfully for nests.

Figure 3. Nest sites of the Red-faced Warblers in the study area, 1965.

(Figure 3)



## INJURY FEIGNING

A female Red-faced Warbler may feign injury if flushed from her nest. The only requisite for display is an open area in which to perform. Since all nests are built on the down slope side of the foliage, providing cover, the female bird has little opportunity to display on the up slope. If I approached a Red-faced Warblers nest from the down slope side, the female would fly off the nest to a nearby perch scolding steadily. If I approached from above a nest, the female would scramble off of her nest with her wings held down and quivering, her tail dragging, and her head arched skyward. The female Red-faced Warblers are tight sitters, and do not flush from their nests until almost stepped upon, and their display portrays what one might expect after having stepped on this small bird.

Feigning an injury is a well developed behavioral trait in Cardellina. Females 3, and 4, feigned injury into my mist nets which were placed about ten feet below their nests. This experience did not bring a halt to their normal habit of jumping off of their nests and sprawling down the slope with their wings and tail dragging.

Vocalizations accompanying this display were a series of twitters, dee-dees, and the normal chip. The display was stronger as the eggs neared hatching and as the female was brooding young. If I followed a displaying female at this time she would fly to a small branch and continue her performance from limb to limb. In all cases the distress calls of a displaying female brought the scolding male and occasionally other inquisitive males.

## CARE AND FEEDING OF THE YOUNG

Young birds are fed regurgitated insects soon after hatching. Female 3 fed the first young bird before the second had hatched. The male of this pair fed the young birds in the absence of the female and before the final egg had hatched. Both the male and female fed the young on the average of twice an hour on the first day (see Figure 4). Both sexes often appeared simultaneously at the nest, and on such occasions the male would often pass food to the female and the female would feed the young.

I observed the female brooding on the first day from 12:40 to 2:40. She spent 79% of these two hours on the nest and made two feeding excursions of 11 and 14 minutes and came back with several insects in her bill. The male brought food to the nest nine times.

The male fed the female while she was on the nest. The female took insects from the male and stood up to feed them to the young. At this time the male removed the fecal sacs from the nest. When the female would leave the nest, the male usually arrived promptly to feed the young.

Pair 6 fed their young 14 times on the fourth day in a period from 2:05 to 3:40 p.m. When the birds were nine days old they were fed 14 times in a half hour by both parents.

As the young feathered, and grew older, both of the adults spent much time feeding the young. A favorite item appeared to be the soft green caterpillars, commonly known as "inch worms". The male and female often fed the young simultaneously, both standing on the rim of the nest (see Figure 4). Neither parent would fly directly into the nest. A parent would alight on a nearby branch, chip, look around, fly to a closer branch, chip, and survey the area, then fly into the nest. Young birds had a dee-dee call, similar to several types of unrelated birds (chickadees, nuthatches, etc.).

The young were completely feathered by the eighth day, although flight feathers and tail feathers were not fully developed. The young of pair 6 were banded and weighed on the ninth day. This disturbance caused the young to leave the nest and take refuge in a large fallen tree. The young were unable to fly, but climbed about the lower branches with the use of their well developed legs and supported by their wings.

The young of nest 3 left their nest on June 14, at the age of ten days. This is also due to my disturbing the young in an attempt to weigh them. The young of pair 4 were not disturbed after the seventh day and they left the nest on June 8, at the age of 13 days. They were then capable of flights up to 20 feet.

Leaving the nest prematurely did no harm to the young birds of pairs 3 and 6. Fledgling sets stayed in the bushes until they learned to fly. The young did not disperse from the general area of the nest until they were able to fly easily. This took place on the 13th day after their hatching. A young bird sitting in a bush or a tree periodically emitted a dee-dee cry to which the parents responded by feeding them. After the 13th day the parents were busier than ever, trying to feed their young that were perhaps five to ten yards apart. The general procedure was for one parent to feed two young and the other parent feed the remaining two. After a young bird's cry, the parent would feed it twice in succession before moving to the second bird. Fledgling's were fed on the average of 12 times an hour. The young often followed the parents, and the family commonly ranged over 200 yards in a day, passing through areas occupied by other Red-faced families. Fifteen day old birds, wherever they happened to be perched, picked insects off of branches. This was not an attempt to search for food but represented curiosity over any moving foreign object in the immediate vicinity.

The disappearance of young from their parents is somewhat a puzzle. The young of pair 3 were not observed after June 19. On June 21, 23, 25, and 26, the banded

female accompanied by the male was observed in the same area and higher up the slope, but I found no young. The young birds flew with ease and often wandered 50 yards from each other. At this time the adult birds followed the young more than the young followed the adults. On June 25, pair 4 fed only one young bird, which was about 100 yards from the old nest site. June 26, pair 4 was back in its nest area and no young were being fed. From this evidence I think that the young became so widely dispersed that the parents were no longer capable of attending to them. It is likely that the parents would feed them for a longer time if they remained close enough.

On June 20, pair 5 fed young in a fir tree about 30 yards from the old nest site. June 23, pair 1 fed young about 25 yards east of the first nest site. Pair 2 fed young about 40 yards above the old nest site. Pair 8 fed young, which may have been still in a nest, about 15 yards below the old nest site. This was evident by observing the male and female carrying food. Efforts to find the young of pair 8 were not successful.

Upon my return to the study area on August 1, all adult birds were present in the same area. I could find no young at this time, or later.

During August, the males sang in the morning, but less frequently than before. Pairs roosted together on

the tops of the tallest trees as before. No further attempts at copulation were observed. By August 30, most females and some males had disappeared from the study area. The remaining males still sang, and mixed freely with flocks of migratory warblers. No Red-faced Warblers were found in the study area after September 4, 1965.

Figure 4. Male and female Red-faced Warblers feeding their young at the nest. Photograph by Eliot Porter.



(Figure 4)

## DISCUSSION AND CONCLUSIONS

In the Santa Catalina Mountains of southern Arizona, the Red-faced Warbler breeds commonly between 7,000 and 8,000 feet. In this range it is most abundant, where ponderosa pine, silverleafed oak and the netleaf oak form the dominant vegetation. Pines are not usually present below 7,000 feet. Pines or firs are apparently a necessity for the Red-faced Warbler, since they are always associated with these trees.

Above 8,000 feet the nesting season is greatly shortened. A pair breeding at 8,600 feet on Mount Lemmon did not begin nest construction until the end of May. In my study area (7,600 feet) at this time, incubation was well under way and the eggs of pair 8 had hatched. Sutton (1943) found young Red-faced Warblers on May 29 at 8,000 feet in the Santa Rita Mountains. The question now arises, how late in the season will Cardellina continue to renest? The latest renesting in the study area was pair 7 which began incubation on June 23. Dr. Williams (in Bent, 1953:617) believes that in the Hooded Warbler (Wilsonia citrina), the advance of the season is the only factor limiting the efforts of the parents to raise young. Walkinshaw (1966) found that Trail's Flycatchers

(Empidonax traillii), will not renest after July 20, in Michigan. He also states that if a female has lost several nests and has laid eight to eleven eggs she will not renest even prior to July 20. Female 7 laid two clutches consisting of eight eggs and then disappeared. It is possible that she had laid her maximum number of eggs. In this instance I see no other reason for her disappearance from the study area. I believe that the Red-faced Warblers will renest until the middle of July. This would provide them with enough time to raise a family before the onset of cold weather.

Without a forest understory, the nest is probably more subject to predation. This suggestion is supported by the loss of six out of eight first nests in the study area, and the success of five out of six second trials. Even on the south facing slope, the understory is not well developed in the early part of May. At higher elevations the understory develops leaves and flowers later. Delay in the development of the vegetation postpones utilization of nesting sites by the Red-faced Warblers. In the study area, Cardellina did not nest on the north facing slope until the end of May. Pairs 6 and 7 attempted to nest along the stream before moving to the north slope on May 33 and 27, respectively.

I did not find Cardellina on the higher parts of

the north slope of Mount Lemmon or Mount Bigelow (8,800 feet). Several areas on the north facing slope at lower elevations (8,600 feet), supported only a few pairs of Cardellina rubrifrons. Marshall Gulch supported at least 32 pairs of Cardellina and 23 of these nested on the south facing slope while the remaining nine pairs nested in the more exposed areas of the north facing slope. I believe that the late blossoming of the understory, the long period of incubation, and the considerable time that the young remain in the nest, explain the absence of Cardellina in the otherwise suitable areas on the north slope of the Santa Catalina Mountains.

These same factors apparently set the northern limits of the range of Cardellina. The 15 to 17 day incubation period with the normal 13 days that the young remain in the nest, is 7 to 10 days longer than the Wilson's Warbler (Brown, in Bent 1953). A shortened breeding cycle is characteristic of all northern genera of Parulidae, as is a longer cycle in Mexican and Central American genera of Parulidae. With the added information on loss of the first clutch of eggs of Cardellina, it appears obvious why they have not successfully inhabited forests of northern Arizona and New Mexico.

Phillips (Phillips, Marshall and Monson, 1964) states that Cardellina is extending its range north and

west in Arizona. This is to be expected in the continuous forest of the Mogollon Plateau, since the Red-faced Warblers have always been present above the Mogollon Rim (Henshaw, 1875). Distribution in this area appears to be discontinuous and flexible, and is typical of peripheral areas in the ranges of most birds. Yearly variation in spring temperatures may be responsible for the flexibility of Cardellina above the Mogollon Rim.

The eastern and western limit of the range of Cardellina in the United States appears to be restricted by geographic barriers. Red-faced Warblers breeding in the Santa Catalina Mountains do not move west into California, simply because there are no pine forests in the intervening area (a distance of about 360 miles). The extreme western edge of the range in Arizona is in the Bradshaw Mountains of Yavapai County. The distance from the Bradshaw Mountains to the Hualpai Mountains (the next pine forest), is about 100 miles. Cardellina may eventually reach this range, as it has recently reached the Bradshaw Mountains (Phillips et al, 1964).

The northeastern limit of the breeding range of Cardellina rubrifrons is in the Magdalena Mountains, Socorro Co., New Mexico (Ligon, 1961). Eastern expansion may take place in the future, across the Rio Grande Basin

There are two mountain ranges with pine forests, east of the Rio Grande. This would produce a mushrooming of the range of Cardellina in the United States, and is not likely to take place, because of the low population density in the mountains west of the Rio Grande. The southern limits of the breeding range of Cardellina is poorly known. The birds have been recorded as far south as Guatemala in the winter (Skutch, in Bent, 1953). Miller, et al (1957) states that Cardellina breed south to Durango. Blake (1953) says that the Red-faced Warblers are widespread on the tableland, south to Oaxaca and Veracruz.

In the study area, the density of Red-faced Warblers is higher than it is in other parts of the Santa Catalina Mountains. The nest of pair 4 was located about 100 yards east of nest 5. Nest 8 was 104 feet southeast of nest 4 and about 200 feet west of nest 3.

In sections of low density, the Red-faced Warblers often have feeding areas as large as 500 yards (Marshall, 1957:110). They also appear to have large feeding areas in places of high density, but this is extremely difficult to observe.

In the study area it was definite that the adult males moved up to 200 yards and in doing so moved through sections occupied by other members of the species.

The Red-faced Warbler appears to be intermediate

in several respects between the Central American genera, Basileuterus and Ergaticus and the North American genus of Wilsonia. It has the same red pigment as Ergaticus, and it lacks sexual dimorphism and seasonal plumage variations, as do Ergaticus and Basileuterus. The trait of obtaining the adult plumage shortly after leaving the nest and having no prenuptial molt is also shared with Ergaticus, Basileuterus, and Myioborus.

The Red-faced Warbler nests on a steep bank or slope and has a 15 to 17 day incubation period similar to Ergaticus and Basileuterus (Skutch, 1954). Previous speculation by Skutch (1954:385), attributing the longer incubation period of Ergaticus, Basileuterus, and Myioborus to the dome shaped nest built by members of these genera, appears to have no justification in review of Cardellina. The shorter reproductive cycle of warblers nesting in the Temperate Zone due to natural selection in a shorter breeding season appears to be a better hypothesis. Warblers nesting in the Temperate Zone have an incubation period from 10 to 12 days, while Central American species incubate from 14 to 17 days.

The young of the Red-faced Warblers normally stay in the nest for 13 days, as is also the case in Ergaticus and Basileuterus, however, young of the Red-faced Warbler can leave as early as nine to ten days. Warblers

of temperate areas have similar short nesting periods. It is probably advantageous for young birds in the tropics to leave the nest only after they have learned to fly, due to the different types of predators present. The young Red-faced Warblers survived out of the nest three days before they were capable of short flights.

Unlike Ergaticus, which usually has three, and Basileuterus which usually has two, Cardellina characteristically has four eggs to a clutch. Wilsonia usually has four eggs to a clutch with the exception of Wilsonia pusilla (The most northern representative of the genus) in which the clutch size is usually four in western United States, five in Canada, and six in Alaska. Cardellina builds an open cup nest on the ground, similar to Wilsonia with the exception of Wilsonia citrina which nests average three feet above the ground. Ergaticus and Basileuterus build domed shaped nests.

Behavior of Cardellina is very similar to Wilsonia. In general both genera are low feeding, fly-catching warblers. Flycatching is performed in a similar business like manner and not in the carefree manner of Myioborus, Dendroica, or Vermivora which may occasionally chase a flying insect. Cardellina and Wilsonia produce the characteristic "snap" of the bill (similar to true flycatchers, Tyrannidae) in the act of flycatching.

The chip call of Cardellina is inseparable by ear from that of Wilsonia, but easily told from other North American genera of Parulidae. The habit of flicking the tail sideways as well as upwards is common to Cardellina and Wilsonia (with the exception of Wilsonia citrina, which replaces the sideward tail jerks with a fanning of the tail). All four species are quite tame around the nest. This is not at all true of other North American genera (Dendroica, Vermivora, etc.).

Morphologically, Cardellina has a distinct bill, higher and shorter than Wilsonia. Within Wilsonia, there is a trend from Wilsonia pusilla to Wilsonia canadensis, to Wilsonia citrina, of a flattening and elongation of the bill. Basileuterus has a higher thicker bill than Cardellina, in most species. Ergaticus has a high ridge bill somewhat similar to Cardellina, but tends to be slimmer and finer pointed.

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