Monitoring Avian Night Flight Calls—The New Century Ahead

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On September 14, 1896, on a small hill outside of Madison, Wisconsin, Orin Libby counted 3600 calls from night-migrating birds in five hours of listening (Libby 1899). This count is the first published record of an attempt to quantify the night flight call phenomenon of North America's avifauna. Native people in Wisconsin likely heard nocturnal bird migrations during the previous 10,000 years.

In the 50 years after Libby's report, only two other counts of nocturnal flight calls were reported, those by Paul Howes (1914) counting Swainson's Thrushes [then called Olive-backed Thrush] in Connecticut and the extraordinary 15-year study by Stanley Ball (1952) counting migrating thrushes in eastern Quebec. Ball's work was the first to use nocturnal flight call monitoring to produce data on the migration timing of species in a region.

Beginning in the 1950s, regular nocturnal flight call counts were reported from regions throughout eastern North America in the *Audubon Field Notes.* Most of the reports were tallies of call totals or of estimated numbers of *Catharus* thrushes passing over during a portion of an evening. One outstanding effort is the long-term work by Ron Weir who has been counting thrush calls in fall migration near Kingston, Ontario for more than 25 years (see *American Birds,* Lake Ontario region, fall reports).

In the 1950s technological developments enabled the first audio recording of nocturnal bird migration. Bill Gunn recorded some short periods of calling from the top of the Imperial Oil building in downtown Toronto in late September 1957. At about the same time, the team of Richard Graber and Bill Cochran were beginning their pioneering nocturnal flight call study in central Illinois (Fig.1). Some recordings of both of these efforts are archived at the Macauley Library of Natural Sounds at Cornell University.

Graber and Cochran were associated with the Illinois Natural History Survey. Cochran was an electrical engineer and designed the recording equipment. He was able to configure a

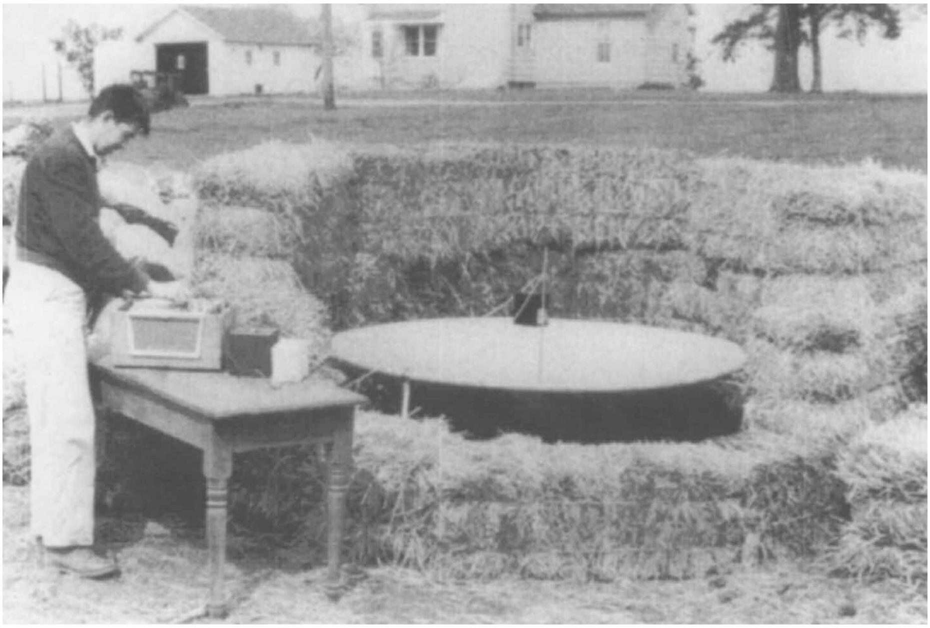


Figure 1. Dick Graber is pictured with night flight call monitoring equipment designed by Bill Cochran at the Illinois Natural History Survey in the late 1950s.

reel-to-reel tape recorder to record for two hours and to automatically record ten minutes out of every hour. By recording ten minutes out of every hour all night long, the device was able to sample night flight calling through the course of an evening. This allowed the researchers to sleep while the machine automatically recorded sounds in the night sky. They would later listen to the recordings and log any bird calls. The method allowed them to study the quantity, and to some degree, the species composition of calling during the course of a night, throughout a migration season, and in different weather conditions. Like Ball, they documented the seasonal timing of migration for a number of species and their work laid the conceptual foundation for machine-based recording of nocturnal flight calls (Graber and Cochran 1959 & 1960).

In his classic 1968 paper, Graber discussed the potential of acoustic monitoring but pointed out several major impediments. One was the labor necessary for the analysis of the calls and the other was deciphering the identity of the many unknown callers. The concept of night flight call monitoring clearly existed in the 1960s, but the method would need some technological developments before it was ready to advance further.

On a late May night in 1985, I was camped on a bluff along the St. Croix River on the Minnesota/Wisconsin border. It was a beautiful late spring evening with a light wind from the south. Shortly after I settled into my sleeping bag my attention was drawn to the faint sounds of birds in night migration. A decade earlier my father had pointed out this night flight calling to me when I was a teenager growing up in southern Minnesota, but I had never heard it again until this night. With nothing else on my mind, I tuned in and was enthralled in wonder for hours by the beauty of voices trickling down from the passing river of birds.

For the past 20 years I have been studying the night flight calling phenomenon across eastern North America. I was motivated by the idea that all-night recordings of events like the one I heard in my camping experience would be of interest to people in the future. I remember being very inspired by Audubon's account of seeing hoards of migrating Passenger Pigeons darkening the skies over southern Ohio back in the early 19th century. I remember the sadness evoked from realizing I would never get to see that original North American wilderness. But then I remember the change to a paradoxical optimism in realizing that the wilderness was only likely to deteriorate further and that at least I was here now and there were still lots of birds migrating. I believed that the all-night, all-season recordings of avian night flight calls would in some way reflect the species composition and numbers of birds on the continent now, and that someone might appreciate this information hundreds of years from now.

By 1985, a lot had changed technologically since Graber and Cochran's recording efforts in the late 1950s. The consumer electronics revolution had begun and for $1000 one could buy a portable hi-fi Video Cassette Recorder (VCR) and make a recording of 8-hours of good quality stereo sound. For the next ten years I would record and listen to thousands of hours of audio tape recordings of the night sky.

A sign of the next technological advance was reported in 1987 by Volker Dierschke, studying the nocturnal flight call phenomenon on Helgoland Island in western Germany (Dierschke 1989). Peter Kaetsch, an engineer working on the project, developed a voice-activated nocturnal flight call recording system. The tape recorder was activated when it received a signal of specified loudness in the 3–8 kHz range. This conserved audio tape and also saved analysis time in allowing one to bypass the long sections of night when no calling occurred.

I have no regrets about the thousands of hours I spent listening to audio tapes, as this experience convinced me more than ever that there is utility in monitoring avian night flight calls. But, the idea of automating the call detection and extraction process had been in my sight since my listening experience in 1985. This dream began to come together in 1994 when I teamed with the Cornell Lab of Ornithology's newly formed Bioacoustics Research Program (BRP) to work on the development of automatic nocturnal flight call detectors. Under the direction of Dr. Chris Clark, BRP was pioneering the development of computer-based (digital) acoustic analysis software. BRP programmer Harold Mills wrote the first functional nocturnal flight call detector in 1994 (Mills 1995). This software for Macintosh computers allowed automatic detection of the short, high-pitched flight calls of warblers and sparrows.

This development allowed the automatic extraction of their flight calls from audio tapes or in real-time directly from an active microphone pointed at the sky.

BRP's spectrographic analysis software called *Canary*, written by Steve Mitchell, was then used to study and help discriminate similar calls. Time-frequency spectrograms allow one to see how the frequency of flight calls varied with time, and *Canary* enabled one to quickly make a spectrogram of a call and make measurements of its fine acoustic features. It was the tool that opened the door to breaking the code of nocturnal flight call identification.

Back in 1990 I had released an audio cassette tape identification guide to the flight calls of night-migrating thrushes. Pirated copies of the tape made the rounds of the birding underground and as I set my sights on the daunting task of completing the warblers and sparrows, I was joined in that effort by Michael O'Brien, an ardent night flight call enthusiast from Rockford, MD. Ten years later we would release a CD-Rom guide to the flight calls of landbirds in eastern North America (Evans and O'Brien, 2002).

In 1998, my myopic focus brought on the creation of an organization dedicated solely to night flight call monitoring, and I founded the nonprofit organization called Old Bird. Old Bird contracted former BRP programmer Steve Mitchell to develop advanced night flight call analysis software. New detectors were written that enabled operation on the more common PC computers. This included the first detector for thrush calls. In addition, software was developed for automatic recognition of one of the most distinctive small passerine night flight calls in eastern North America, the Dickcissel. Using Dickcissel call detection software, the first transect of automated night flight call recording stations was established in spring 2000 at a network of high schools in south Texas (see www.oldbird.org/dicks.html).

A big advance at this time was Mitchell's development of the software called *GlassOFire* that greatly facilitated the sorting of extracted bird calls into user-determined species categories.

Now, 20 years after I bought my first VCR, a similarly capable VCR costs only $50. But, VCRs have become almost obsolete for night flight call recording. Advances in the speed, software, and information storage capacity of computers make it much more efficient to record sound directly to a computer. Having a digital sound file allows one to run the automatic call detection software directly on the file. For a typical modern PC it takes about 20 minutes to extract the warbler and sparrow calls on an 8-hour sound file. This way one can capture and archive the whole night and use different software to extract different species groups, and apply new software as it is developed in the coming years.

Given the rapid advances in technology in the last 20 years, one can imagine that in the next 20 years there will be software for automatically identifying many of the species and that there will be automatic monitoring networks across the continent. I have no doubt that birders will someday wake up in the morning and, with a cup of shade-grown coffee in hand, tune in to continental images of the previous night's migration for many songbirds across the Americas.

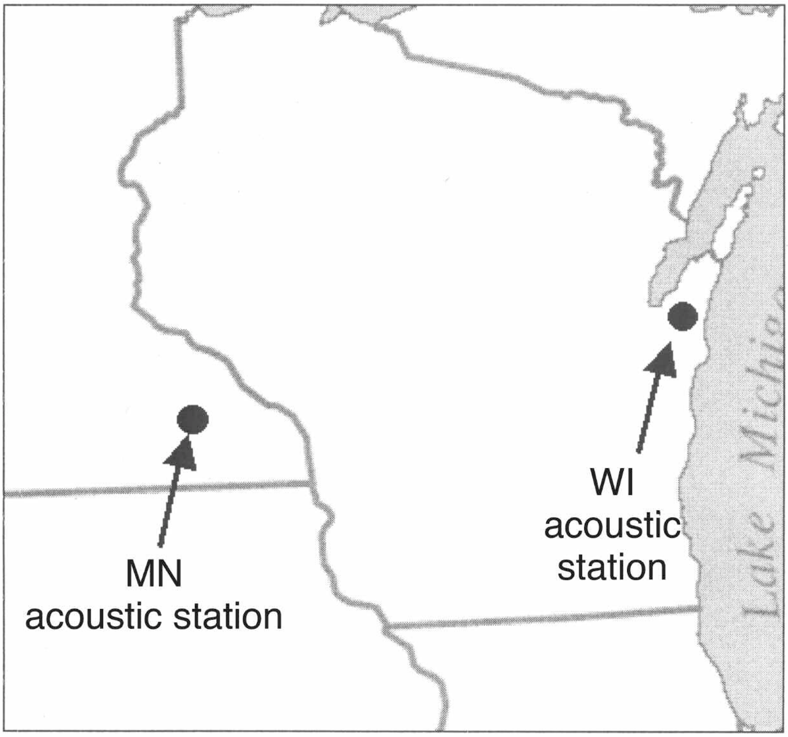


Figure 2. Locations of night flight call monitoring station in the upper Midwest in fall 2000 and 2001.

NEXRAD radar allows us to see the mass migrations now, but acoustics is the only means we have for resolving those masses to species.

In the meantime, the study of avian night flight calls is only in its infancy and holds a lot of promise. Right now the phenomenon is wide open for exploration and interesting discoveries are likely to be made by anyone who undertakes monitoring. Indeed, the really exciting discoveries are likely to come when birders start monitoring from their homes and start comparing data with one another. Building an acoustic monitoring station is also a great school project, and more than 30 high schools in the eastern U.S. have been involved with night flight call monitoring.

The www.oldbird.org website has instructions and the design for a simple but effective microphone for picking up night flight calls of migrating birds. It costs about $30 and takes an hour and a half to build. The software for call extraction and analysis can all be downloaded from the website. A spectrogram library of common call types is available as well as many publications and reports on night flight call monitoring.

Besides the scientific value of night flight call monitoring, it is a great way to build your yard list. All sorts of interesting birds that we would never see during the day pass over in night migration: rails, bitterns, Upland Sandpiper and other shorebirds, waterfowl, and many uncommon songbirds. More than 100 years after Orin Libby tallied thousands of flight calls in a night near Madison, Wisconsin, it is still possible today to hear thousands of calls on big migration nights in Wisconsin, though the species proportions have likely changed.

In hopes of stimulating others to explore night flight call monitoring in Wisconsin, I present some data below that were recorded at two upper Midwest sites in 2000 and 2001 (Fig.2). The Minnesota station was on the roof of my dad's house in Oronoco, MN and the Wisconsin station was on the roof of the Green Bay Water Filtration Plant, about 15 km east of Green Bay. The Minnesota station operated in the fall of 2000 and 2001. The Wisconsin station operated in the fall of 2001. Both stations used the microphone design on the www.oldbird.org website and both operated between August 18 and October 17. Monitoring occurred nightly from 8:30 p.m. to 4:30 a.m. EDT (8-hrs./night).

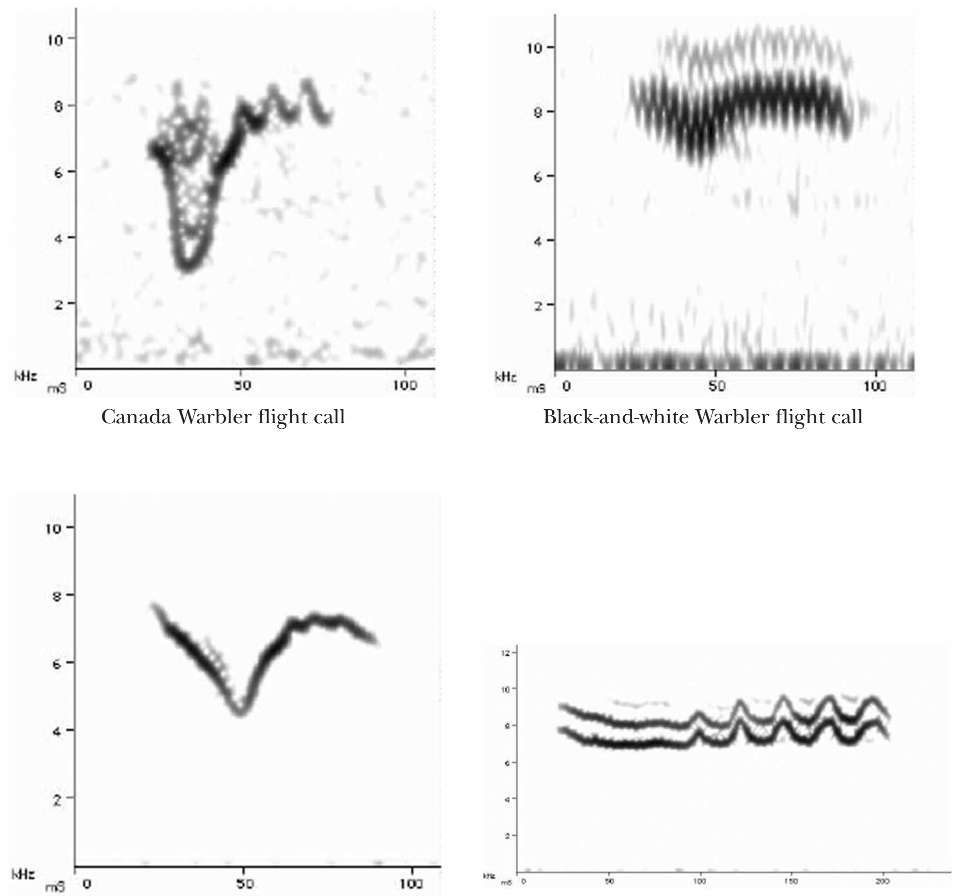
Warbler and sparrow calls were extracted with Old Bird's *Tseep* detector and call totals and temporal occurrences of four species were analyzed: Canada Warbler (*Wilsonia canadensis*), Black-and-white Warbler (*Mniotilta varia*), American Redstart (*Setophaga ruticilla*), and White-throated Sparrow (*Zonotrichia albicollis*). Typical flight call spectrograms of these species are illustrated in Figure 3.

Table 1 shows the total number of warbler and sparrow calls detected at each acoustic station in comparison to the total number of calls detected for each of the four species studied. Fig. 4 shows the proportion of each species' calls during the nearly two month monitoring period.

These preliminary data show some interesting patterns. Black-and-white Warbler and Canada Warbler calling each composed around the 0.5 percent of the total calling. This was true in the fall of 2000 and 2001 in Minnesota and in the 2001 fall season in Wisconsin. White-throated Sparrow calls composed 1.5–2.0 percent of all

Table 1. Total calls and calls of four species detected from August 18 through October 17 at acoustic stations in Minnesota (2000 & 2001) and Wisconsin (2001). AMRE = American Redstart, WTSP = White-throated Sparrow, BAWW = Black-and-white Warbler, CAWA = Canada Warbler. Monitoring occurred nightly from 8:30PM to 4:30AM (8-hrs./night).

	Fall 2000—MN	Fall 2001—MN	Fall 2001—WI
AMRE	571	511	204
WTSP	141	234	160
BAWW	44	72	28
CAWA	85	41	49
Total calls	9671	11377	8525



Canada Warbler flight call

Black-and-white Warbler flight call

American Redstart flight call

White-throated Sparrow flight call

Figure 3. Distinctive night flight call spectrograms of four species studied in the 2000 and 2001 fall data from Minnesota and Wisconsin.

calls. This was also similar between both seasons in Minnesota and the single season in Wisconsin. American Redstart had the largest percentage of calls at both stations, but the percentage was distinctly higher at the Minnesota station for these species in both years (between 4% and 6% of total calls in Minnesota compared with less than 2.5% in Wisconsin). This suggests to me that American Redstarts may be relatively more common in western Wisconsin than in eastern Wisconsin. There are certainly too few data here to make any firm conclusions, but I pass it along in hopes of enticing someone to try to confirm or disprove the pattern.

Here are a few notes to consider before you embark on the road to estab-

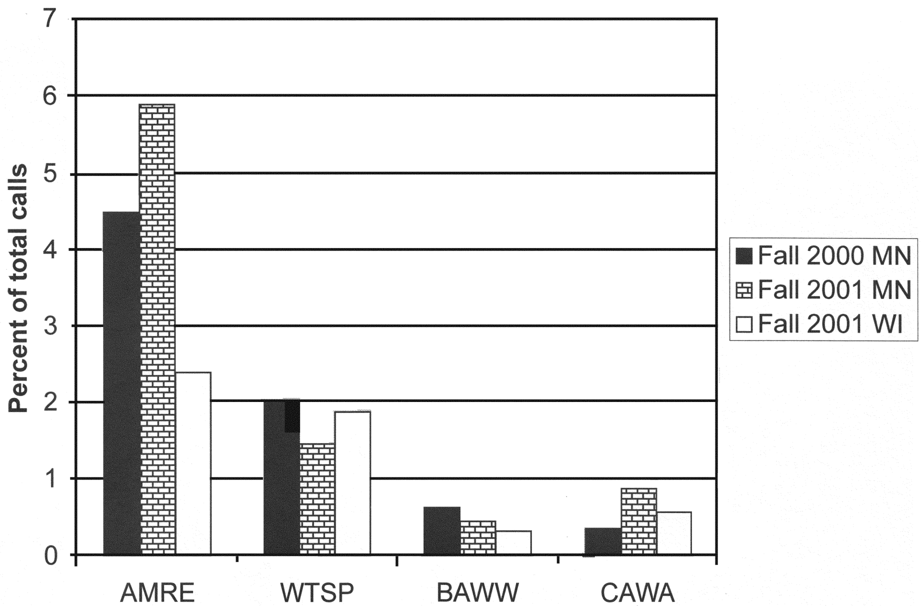


Figure 4. Comparative percent of calling from four species studied in the 2000 and 2001 fall data from Minnesota and Wisconsin. AMRE = American Redstart, WTSP = White-throated Sparrow, BAWW = Black-and-white Warbler, CAWA = Canada Warbler.

lishing a night flight call monitoring station. There are two important considerations in determining a location for an acoustic monitoring station. One is extraneous environmental noise. If your location is near a population of Spring Peepers *(Hyla crucifer)*, this will impede your ability to hear and also to automatically detect thrushes. If your location is close to one or more singing insects, this may impede your ability to detect warbler and sparrow calls. A distant insect chorus is usually present everywhere in the fall migration and that is usually not a problem. What can be a major problem, especially if you want to use automatic call extraction software, is if you have individual crickets, etc. singing close to your microphone. Their individual calls can be similar in duration and frequency to warbler and sparrow calls. In such a case, you could end up with thousands of false detections in an evening and a more time-consuming task in separating bird calls from false detections. Oddly enough, proximity to highways and road noise is not a problem, especially if you are just monitoring warblers and sparrows. The calls of these species have frequencies above the lower rumble of typical auto traffic.

Artificial lighting is an important factor that can cause disoriented individual birds to call more rapidly when there is low cloud cover. Such conditions can be detected by the appearance of abnormally high call rates. A tell-tale sign is if an individual warbler or sparrow gives a series of calls, each less than a second apart. In general, residential lighting at night does not cause this phenomenon, but it may be caused by brightly lit convenience stores, parking lots, and city areas. In fall of 2001, besides the acoustic monitoring station on the Green Bay Water Filtration Plant, I had another acoustic station on the west shore of Lake Michigan, 15 km east-northeast of the water filtration station. The site of the recording station was Algoma High School. The school was brightly lit at night and on cloudy nights huge calling events were recorded at this station. On several nights more than 5000 warbler and sparrow calls were recorded, undoubtedly many calls from the same individuals. Yet on these nights the water filtration station and other sparsely-lighted acoustic stations in the area only logged several hundred calls.

It is difficult making comparisons of raw call totals between different acoustic stations. Differences in equipment and environmental variables complicate the comparison by typically causing one station to have more or less background noise. The call detectors work by sensing a certain threshold of sound energy above the background noise in a specified frequency band. So, if one station has twice the background noise as another, that former station will not detect weak calls that the latter station might.

However, if one is using reasonably sensitive microphones, one can compare the ratio of the number of calls detected from a species to the total calls detected and/or the ratio betweeen different species' calls. In these comparative methods, the equipment and environmental variables tend to drop out. The ratio data between the number of calls of different species can even be compared to the ratios obtained from banding stations if appropriate species are selected. For example, it would be interesting to see how passerine banding ratios from Wisconsin compare with the night flight call ratios presented in this paper. Are Canada Warbler and Black-and-white Warbler banded in approximately one to one ratios? Of course, in order to do this, one would need to evaluate other variables like whether the nets were set so as to have a good chance of catching both species. It is unlikely that comparing the proportion of calling from one species with all calls detected would compare favorably with a similar banding comparison. This is because many species (e.g., grassland sparrows) are detected acoustically that would not be represented by banding data. Conversely, some species will be banded that are not known to give regular flight calls (e.g., vireos, catbird).

The flights will be happening again soon. At this point, I simply must encourage you to get out and listen up or, if you are moved to do so, build your own monitoring station and start networking with others. I conclude with a beautiful description of the night flight call phenomenon from Libby (1899).

> Nothing but an actual experience of a similar kind can at all adequately convey the impression produced by such observations. The air seemed at times fairly alive with invisible birds as the calls rang out, now sharply and near at hand, and now faintly and far away. Repeatedly it seemed as if some of the nearer ones must be visible, so vividly was their presence felt as they passed overhead. All varieties of bird calls came sounding out of the darkness that evening. The harsh squawk of a water bird would be followed by the musical chink of the

Bobolink. Almost human many of them seemed, too, and it was not difficult to imagine that they expressed a whole range of emotions from anxiety and fear up to good-fellowship and joy. The fine shrill notes of the smaller Sparrows or Warblers were heard only close at hand but the louder ones came from all along the line, east and west. More than once an entire flock, distinct by the unity of their calls, came into range and passed out of hearing, keeping up their regular formation with the precision of a swiftly moving but orderly body of horsemen. The great space of air above swarmed with life. Singly or in groups, large and small, or more seldom in a great throng the hurrying myriads pressed southward. It was a marvel and a mystery enacted under the cover of night, and of which only fugitive tidings reached the listeners below.—Orin Libby 1899

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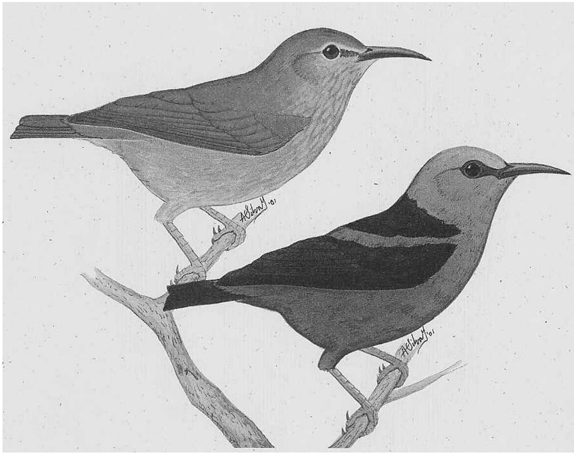

Red-legged Honeycreeper, pair