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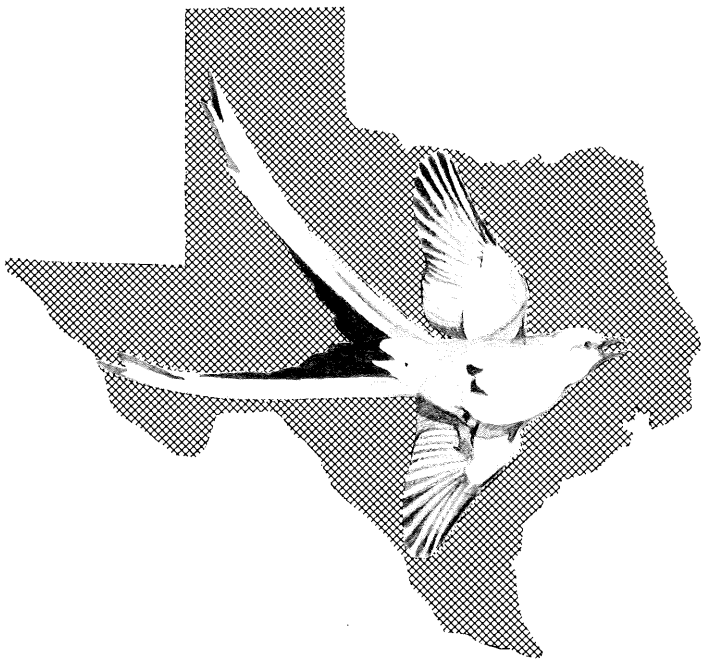

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The Pine Warbler Song Repertoire: A Preliminary Description and Analysis

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ABSTRACT.—The song repertoire of the Pine Warbler (*Dendroica pinus*) was investigated in Bastrop, Grimes, and Montgomery counties in east-central Texas. The Pine Warbler, formerly credited with only two note types, was found to sing at least 22 distinct note types. These note types appeared singly or in combination, as songs. Song recordings were analyzed for repertoire size using the exponential and power model calculations. Markov analysis revealed non-random sequencing of note types which can be predicted by a first order process. Note and note-transition types were identified to be of greater number and variety than previously reported for this species.

Introduction

Repertoire size among passerine birds varies greatly, ranging from only one song in the White-throated Sparrow (*Zonotrichia albicollis*), Field Sparrow (*Spizella pusilla*), and Indigo Bunting (*Passerina cyanea*) (Derrickson 1988; Krebs and Kroodsma 1980) to several hundred distinct songs per male in the Sedge Wren (*Cistothorus platensis*), Rock Wren (*Salpinctes obsoletus*), and Marsh Wren (*Cistothorus palustris*) (Kroodsma and Verner 1987). Many factors have been shown to influence the size of an individual's repertoire, including enhancement of individual recognition (Lemon 1965; Brooks and Falls 1975), sexual selection (Lein 1978; Derrickson 1987), and success in territorial competition (Krebs and Kroodsma 1980).

The song of the adult male Pine Warbler (*Dendroica pinus*) is a relatively high trill that ranges from 3–6 kHz and lasts from 1.2–2.6 seconds (Borror and Gunn 1985). Borror and Gunn (1985), reporting on the only known research on the repertoire of the Pine Warbler song, concluded that the species had a repertoire size of only two distinct song types. Since little is known about the natural behavior of the Pine Warbler, few correlations can be drawn between characteristics of the song repertoire and bird's behavior. This study investigates the Pine Warbler song repertoire for size and patterns of presentation.

Materials and Methods

Field sites and recording protocol.—Twenty-two song recordings of individual Pine Warblers were made from March until May during 1990 and 1991 in Bastrop (N = 2), Grimes (N = 15) and Montgomery (N = 5) counties of east-central Texas. Grimes and Montgomery are adjacent counties, with Bastrop located approxi-

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mately 140 km to the west. Recordings were made between 0700 and 1100 hrs using either a Sony TCD-5M or SV-255 recorder and a Sennheiser ME88 shotgun microphone with a SME-BA (9V) amp. Continuous recording was made of each individual bird until singing ceased, or its song became indistinguishable by ear from that of a neighbor.

Data analysis.—The initial analysis of field recordings was made from sonograms produced by a Kay elemetrics 5500 DSP Sono-graph with 300 Hz filter setting, an RDAT Panasonic SV-3500 digital audio tape deck, and IBM PC AT. Sonograms were printed for each new note and used to visually analyze and classify the number of distinct note types. Each new note was compared to previous sonograms to allow consistent differentiation between new notes and variability in individual expression.

Terminology.—A note type is defined here as a discrete sonogram tracing that occurs repeatedly. A song may be composed of one or more note types. Single note songs contain one note type only; whereas, a combination song contains two or more note types joined without a perceptible delay. Songs were defined by the following criteria: (1) the time interval between notes must be shorter than the interval between vocalizations, and (2) the song must be consistently repeated with very little variation (Derrickson 1987). We defined a song transition as a change from the one song to another. A note transition occurs when two distinct note types are sung in succession, within the same song. The transition between note types generally has a shape as the mixture of the two notes of the song (Figure 1B).

Repertoire size determination.—Repertoire size was estimated for both Grimes and Montgomery counties; Bastrop county was not included due to exceptionally small sample size. These estimates represent the repertoire size for the acoustic neighborhoods that were sampled and, therefore, are not direct estimates for the complete population of Pine Warblers. There are several methods used to estimate repertoire size. We employed two: the exponential and power models (Wildenthal 1965; Selby 1969). Using the exponential model (Wildenthal 1965), N, the estimated number of distinct songs in the total repertoire, was derived from the following equation:

$$n = N(1 - e^{-T/N})$$

where n is the number of distinct notes in the sample and T is the total number of song types in the sample. The exponential model fits the number of distinct note types versus the accumulated number of song transitions observed in the sample (Wildenthal 1965). The asymptote to the resulting exponential curve is the estimated sample size. The regulations governing the use of this equation and its potential problems are outlined in Krebs and Kroodsma (1980) and will be discussed later in this paper.

The power model estimates the repertoire size through the use of a logarithmic, least squares regression curve (Fagen and Goldman 1977). Y, the resulting estimate, is determined in the following equation:

$$Y = CX^z$$

where X is the total number of song transitions in the sample, the C and z represent constants in the model (Selby 1969). This model also plots the distinct number

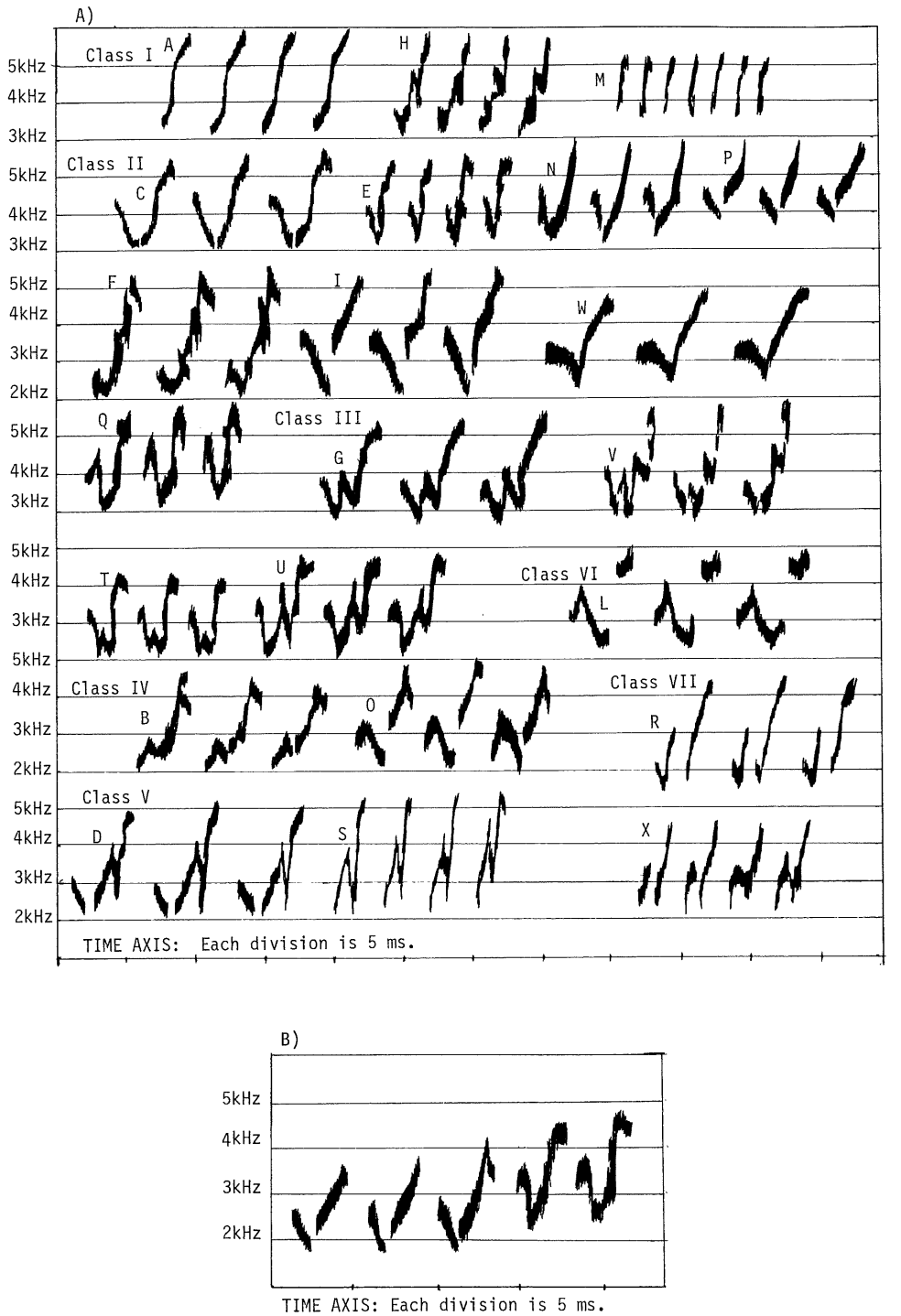

Fig. 1. Sonograms of Pine Warbler note types. A) Notes are grouped according to class. Axes are labelled with frequency and time durations. B) An example of a note transition.

of note types against the accumulated number of song transitions to estimate the repertoire size.

Duration between some note types (e.g., note A vs. note C) varied; however, duration of notes was constant within designated classes (Figure 1). Note rate remained relatively constant, although class I notes did exhibit five to ten more notes per song for the same time period than the other classes. More detailed studies are required for a more comprehensive and statistical analysis of Pine Warbler note characteristics.

Markov analysis. —Song or note sequences can be examined by Markov analysis to determine if the occurrence of note types is random or contains some degree of predictability (Lehner 1979). First-order Markov analysis determines whether the probability of an event occurring is dependent upon the preceding event and involves comparison of observed occurrences with those of a random model (Cane 1978; Lehner 1979).

Markov chains were generated as described by Lehner (1979). Transitions from one note type to another were determined through sonogram analysis, and the observed and expected transition frequencies for each individual were pooled according to county. Transition matrices for each county were then constructed from the Markov chains. Within each transition matrix, the observed and expected occurrences were recorded. If a recording was not continuous or an unidentifiable note interrupted the period, the period was divided into more than one session. Predictability of note occurrences was examined for each county by comparing the observed note occurrences with the expected or random note occurrences. Individual cells in the matrices were inspected for frequencies of observed occurrences that were larger than expected occurrences.

Results

Repertoire size determination.—Upon examination of all the sonograms, we determined that there were 22 different note types, each varying temporally as well as in frequency range (see Figure 1). While no warbler sang all 22 of the observed note types, most were shown to sing more than one. Of the 22, six occurred only in Grimes county (C, D, F, G, N, and O); eight occurred only in Montgomery county (Q, R, S, T, U, V, W, and X); and six note types were common to both counties (A, B, E, H, I, and M). Two note types, L and P (recorded in Bastrop and Grimes counties, respectively), appeared only in combination songs; all others appeared in either single note-type songs or combination songs. To facilitate repertoire discussion, the note types were grouped into classes according to similarities in contour. Each note within a class is distinguished from its fellows by form and frequency range. Seven note classes were defined: class I contained three note types (A, H, and M) which were formed by a relatively simple "slash" movement. Class II was the largest class, containing eight note types (C, E, F, I, N, P, Q, and W). Their general movement consisted of a down stroke, immediately followed by an up stroke forming a "single check mark." The two movements may or may not be joined, and the second is generally of greater duration than the first. Each of four note types in class III (G, T, U, and V) was formed from a general down-up-down configuration producing a "dual check mark" pattern. The two note types (B and O) of class IV had a small chevron, followed by an up slash and a shorter downwards movement resulting in a "reclining" configuration.

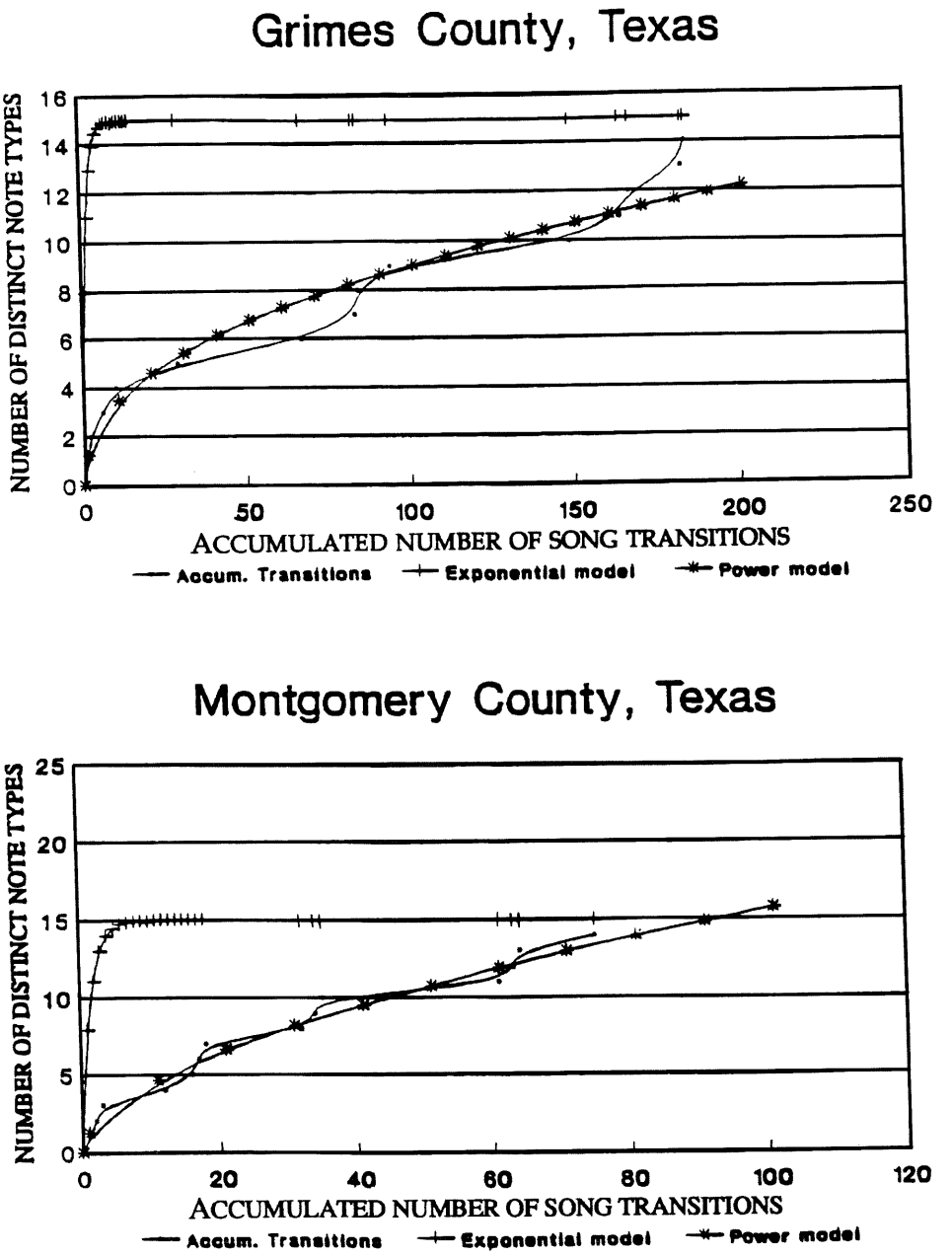

Fig. 2. Pine Warbler song repertoire size estimates for Grimes and Montgomery counties.

The general shape for note types of class V (D and S) was a continuous rapid up-down formation resulting in a "pogo stick"-like configuration. One note type (L) defined class VI. This note traced two distinct marks, the first was a continuous up-down formation, the second appeared as a short, thick up-down formation, occurring at a higher frequency than the first. This produced a "sea-bird"-like pattern. Class VII (R and X) traced two apparently distinct marks. The general

Table 1. Summary of data of Pine Warbler vocalization recordings from Grimes and Montgomery counties.

	Grimes	Montgomery
Number of distinct note types (n)	14	15
Accumulated number of song transitions	184	75
Estimated number of song types		
exponential model (N)	15	15
power model (Y)	12	13
Number of individuals recorded	15	5
Total number of songs recorded	620	188

* Bastrop county omitted from analyses due to small sample size (N = 2).

movement of both marks was an up stroke, with the second being larger than the first giving the appearance of a "double" configuration.

The onset of songs was often characterized by one or two notes with incomplete contour patterns from the descriptions given above. The notes eventually become sharper and more consistent with repetition. In combination songs, we noted occasional transition notes between the first and second note type. Transitions were observed at any point within the song duration, but generally occurred after about ten notes were sung (if, indeed, a combination song was sung). These were either imperfect versions of the second note or a hybrid of the two. Alternatively, a smooth, or evenly contoured, transition occurred from the first to second note type without distortion. Combination songs generally consisted of two note types; only once did we find a combination song composed of three different notes.

For both Grimes and Montgomery counties, the total number of distinct note types were plotted as a function of the accumulated number of transitions between song types (see Figure 2). The Grimes county sample contained a total of 14 different note types and 184 accumulated transitions in a sample of 620 total songs (Table 1). Montgomery county contained 15 distinct note types, but with 75 accumulated transitions in a total of 188 songs (Table 1). Using the appropriate equations, each model estimated the total repertoire of each county based on the total number of accumulated transitions in the sample. The exponential model estimated N at 15 for both Grimes and Montgomery counties (Figure 2). The apparent lack of adequate fit between our data and the exponential model required use of the second analytic method: the power model. The power model estimated repertoires of 12 and 13 for Grimes and Montgomery counties, respectively (Table 1). Predictive use of the power model with a much larger number of song transitions (e.g., 250, Figure 2) would still yield an estimated repertoire size close to our observed (i.e., 14–15, Figure 2).

Markov analysis.—A total of six transitions from one note type to another and four different note types were observed in Bastrop county. All six observed transition frequencies exceeded their expected occurrence.

In Grimes county, 73 transitions and 29 different note types were observed. Seventy-three percent (N = 53) of the transitions exceeded their expected values. Seventeen percent (N = 9) of the 73 transitions consisted of two of the same note types. Three percent (N = 1) of the transitions occurred with the expected frequency and 26% (N = 19) occurred less often than was expected.

In Montgomery county, 57 transitions and 21 different note types were observed. Ninety-one percent (N = 52) of the transition frequencies exceeded their

expected values. Sixteen percent (N = 9) of the 52 consisted of two of the same note types. Three percent (N = 2) of the transitions occurred with their expected frequencies and 5% (N = 3) occurred less often than expected.

A total of 136 transitions and 22 different note types were observed for all counties combined. Combined totals resulted in 82% (N = 112) of the observed transitions exceeding expected occurrences, 13% (N = 15) consisting of two of the same note type, 2% (N = 3) occurring with their expected frequencies, and 16% (N = 22) occurring less often than expected.

Discussion

Through this study we have increased the formal documentation of the Pine Warbler repertoire from two to 22 note types and estimated local repertoire sizes. However, the determination of repertoires in passerine birds can be a formidable undertaking, and our estimates may be flawed due to problems within the models utilized. In order for either the exponential or the power model to be accurate, the data must meet certain criteria: (1) songs must occur in random sequences and (2) each note type must occur with equal probability. A priori, both of these assumptions are violated because the birds do not sing in random sequences, but rather, display characteristics of first order Markov processes. In addition, some song types occur often (e.g., A in the sequence ABAACAAB), while others occur rarely; therefore, not all song types have an equal chance of occurrence (Weins 1982; Martin 1990). A third factor that may limit the effectiveness of the models is our relatively small sample size.

Obviously, both models have limitations. While the exponential model estimates the repertoire size to be 15 for both counties, inadequate fit with the data and violation of the aforementioned assumptions challenge its accuracy. The power model suffers from the same problems, but seems to reflect the distribution of our data more accurately. With estimates of 12 and 13, however, it may underestimate the total repertory size of the local populations. An additional problem with the power model is the power-based equation; the equation does not give a limit to the total repertoire size until the number of accumulated transitions between note types reaches infinity. Despite these problems, the models predict similar local repertory sizes for Grimes and Montgomery counties which implies a measure of validity (Figure 2).

The large percentage of the observed transitions that substantially exceeded the expected number generated by a random model indicated some predictability in note sequencing consistent with a first-order Markov process. However, a higher-order process may be needed to describe the remaining transitions. The quantity of note types and the apparent non-random nature of their presentation provides a source for future studies on note function.

Repertoire sizes for Grimes and Montgomery counties are extensive; yet no single individual sang the entire range of note types. These two features suggest that there may be geographic variation in the Pine Warbler repertoire. Geographical variation has been defined in many different ways: it may be evidenced by specific use of note types, note duration, frequency, or sequencing (Weins 1982). In our case, variation investigation was performed by recording the frequency of note type use. While statistical analysis was not an option, due primarily to small sample size, the distribution of note types in our data suggest that geographical

variation might occur in the expressed repertoire. This conclusion is strengthened by the fact that 566 single note songs were obtained for Grimes county, as opposed to the 168 for Montgomery. Small scale variation of this nature is not surprising due to the size of the repertoire studied.

A number of factors may influence repertoire variation including, but not limited to, the degree and accuracy of learning, dispersal distance and genetic isolation (Krebs and Kroodsma 1980), and these influences are confounded by a large repertoire. Weins (1982) notes that while sharp geographical-variation boundaries have been found between populations in some species, it is entirely possible for songs to vary along a continuum within and between populations. Our data suggest that such a continuum in distribution of notes may be appropriate when describing the Pine Warbler repertoire. If this is the case, then a dialect study would discover the complete repertoire of geographically dispersed individuals and compare the frequency in use of different notes.

Additional research on Pine Warblers is necessary for statistical analysis of song, note sequences and geographical variation. Non-vocal behavioral research is also needed for understanding the vocal behavior and for placing it within the theoretical framework appropriate for comparison across individuals, populations and species.

Acknowledgments

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Additions to the Breeding Avifauna of the Davis Mountains

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ABSTRACT.—In 1990, sight records of six unusual Texas breeding birds by Webb and Howell were recorded from one 7.5 minute U.S.G.S. topographic quadrangle in the Davis Mountains of Texas (Lasley and Sexton 1990). Included in the observations was a report of a nesting Gray Flycatcher (*Empidonax wrightii*)—a species with no previous nest records in the state of Texas. A follow-up survey to document this potential new nesting species and to determine the status of other breeding birds in the higher elevations of the Davis Mountains was made from 1 June through 8 June 1991 by the authors. Mark Lockwood's observations were contributed within a three week span from 3 June to 27 June 1991. During the entire survey period, twelve species were observed whose exact breeding status in the Davis Mountains was previously unknown.

Study Area

The Davis Mountains are primarily a mountain range of volcanic origin confined mainly to Jeff Davis County in the northern portion of the Chihuahuan biotic province of Trans-Pecos Texas. Like the Guadalupe and Chisos Mountains of west Texas, the Davis Mountains have islands of montane habitat that begin at an elevation of about 1,400 m. The highest point in the Davis Mountains is Mount Livermore at 2,579 m. Our survey of the avifauna was concerned primarily with montane habitat along the north slope of Mt. Livermore and some adjoining areas down to a 1,815 m elevation. The survey area included locations primarily within the Mt. Livermore and Mt. Locke topographic map quadrangles. All surveyed areas were within private property.

Vegetation

The basic vegetation of the Davis Mountains above 1,500 m elevation is best characterized as an evergreen montane woodland with an oak mid-story and a grassland for a ground cover. This woodland has also been referred to by Powell (1988) as a remnant coniferous forest mixed with oaks. Natural fire, which mainly occurs during the dry season from late winter to early summer, is the major ecological factor shaping the Davis Mountains vegetation. As such, a shrub component is missing or is restricted throughout most of the mountain range and is replaced by a well developed, highly diversified grassland component.

The evergreen component is comprised of three basic species which occur throughout the area: alligator juniper (*Juniperus deppeana*), Mexican pinyon pine

(*Pinus cembroides*), and ponderosa pine (*P. ponderosa*). One additional evergreen species, limber pine (*P. strobiformis*), occurs primarily at the higher elevations. Six species of oaks are well represented in the study area. Emory oak (*Quercus emoryi*) occurs at the lowest elevation and is gradually replaced by whiteleaf oak (*Q. hypoleucoides*) and Chisos red oak (*Q. gravesii*) at the mid-range elevations. Gambel oak (*Q. gambelii*) generally replaces the mid-range species at the higher elevations and is most common above 2,150 m. Finally gray oak (*Q. grisea*) occurs at all elevations. Near the summit of Mt. Livermore, however, this species is displaced by stunted woodland thickets and dense shinneries of Mexican dwarf oak (*Q. depressipes*).

Several other mid-story trees in the survey area that deserve mention include quaking aspen (*Populus tremuloides*), Texas madrone (*Arbutus xalapensis*), birchleaf buckthorn (*Rhamnus betulifolia*), mountain mahogany (*Cercocarpus montanus*), and wild cherry (*Prunus virens*) at mid to higher elevations and netleaf hackberry (*Celtis reticulata*) and arizona walnut (*Juglans major*) at mid to lower elevations. Near the summit of Mt. Livermore, bush rock-spires (*Holodiscus discolor*), mountain snowberry (*Symphoricarpos oreophilus*), cliff fendlerbush (*Fendlera rupicola*), and mockorange (*Philidelphus crinitus*) are important shrub components of the woody vegetation.

Current Problems of Status and Distribution

What is known about the avifaunal abundance and distribution within the Davis Mountains is largely a conglomeration of sight records and natural history surveys. The most significant existing information is summarized in two publications; *Birds of the Davis Mountains State Park and vicinity: a seasonal checklist* by Espy and Williams (1991), and *Birds of Jeff Davis County* by Espy and Miller (1972). The typical habitat occurring in most of Jeff Davis County including the Davis Mountains State Park, however, is predominantly made up of desert shrub and grassland formations (Warnock 1977). The more heavily wooded montane habitat in the Davis Mountains, particularly in areas above 1,850 m has had far fewer sight records than other areas within the county and only minimal survey coverage. Outside of independent sight records, only Popper (1951) and Wauer and Ligon (1974) have reported on the Davis Mountains breeding avifauna specific to montane habitat. A natural area survey which included information on the avifauna in the higher elevations was conducted previously (LBJ School of Public Affairs 1973), but the study was general in its scope and did not contain detailed information on the breeding avifauna.

Unlike the two other major mountain ranges in the Trans-Pecos, the Chisos and Guadalupe Mountains, most of the Davis Mountains are privately owned. Generous access to property has been granted for scientific studies by many landowners in the past. It is probably fair to say, however, that comprehensive surveys are more difficult to initiate because of access restrictions than in either the Chisos or the Guadalupe Mountains, which are largely controlled by the National Park Service.

Also relevant to abundance and distributional studies of the avifauna is the fact that Jeff Davis County's population is less than 1,800 people and includes very few birdwatchers. The county itself is 584,822 ha—almost twice as large as the state of Rhode Island. Written records of unusual bird observations by outside

observers are infrequent and usually from the Davis Mountains State Park, which occupies less than 1,000 ha.

Methods

This survey began 1 June 1991 and ended 8 June 1991. Within the Mt. Livermore 7.5 minute U.S.G.S. topographic quadrangle, approximately 35 hours were spent in observation during daylight hours and 2 hours of owling after sunset. About 25 hours of daylight observation and 3 hours of owling were completed in the Mt. Locke 7.5 minute U.S.G.S. topographic quadrangle. These hours do not include the survey time of Lockwood. Most of his sightings were within the Paradise Mountain topographic quadrangle immediately south of the Mt. Livermore quadrangle.

All habitat formations surveyed were considered woodland and forest as outlined by Warnock (1977) and Powell (1988). A daily checklist of the avifauna was kept along with the numbers of each species observed. Elevation was checked by altimeter and topographic map bench mark whenever possible. In the case of Gray Flycatchers, territories were estimated and mapped.

All recorded data concerning the breeding avifauna were organized using Texas Breeding Bird Atlas Project (TBBAP) categories and codes (Arnold 1987) and are on file with the TBBAP at Texas A&M University in College Station, Texas. Birds were photographed and taped whenever possible. Photographs are on file with the Texas Photo Record File also at Texas A&M University. Tape recordings are on file with the Texas Bird Sounds Library at Sam Houston State University in Huntsville, Texas.

It should be noted that Northern Saw-whet Owl (*Aegolius acadicus*) and Dusky-capped Flycatcher (*Myiarchus tuberculifer*) have currently occurred on an average of four or fewer times per year in Texas on a ten year average and are considered "review species" by the Texas Bird Records Committee (TBRC) of the Texas Ornithological Society. Both of these review species were well photographed at the time of observation. Vocalizations by the Dusky-capped Flycatcher were taped during the first sighting, and at least two varieties of song were clearly recorded. The record for Northern Saw-whet Owl included written information on several diagnostic calls described by Lockwood.

Identification of Gray Flycatcher was verified by photographs, tape recordings, sight descriptions and behavioral characteristics. Tape recordings of this species are of several individuals and include a variety of diagnostic songs and calls. A nest with three young was photographed by Lasley and Bryan.

Breeding Status of Selected Species

Most of the following species should be considered as "probable" or "confirmed" breeding birds in the Davis Mountains. The exceptions include the two review species, Dusky-capped Flycatcher and Northern Saw-whet Owl, which should be considered as documented summer records until more breeding information can be gathered, and Brown Creeper (*Certhia americana*) which gave no indication of breeding behavior.

Flammulated Owl (*Otus flammeolus*).—Although this species was a presumed nester in one report (Wauer and Ligon 1974), we know of very few sight records for the Davis Mountains. An adult Flammulated Owl was captured in a mist net

Fig. 1. This adult Gray Flycatcher was one of a nesting pair observed in the Davis Mountains on 8 June 1991. Photo (TPRF #912A) by Greg W. Lasley.

on 14 September 1986 within the Mt. Livermore topographic quadrangle, but the date of this sighting does not necessarily indicate breeding status (Burt et al. 1987). We observed two Flammulated Owls that appeared to be paired on 4 June 1991 at an elevation of 2,250 m on a heavily wooded slope of ponderosa pine. Single birds were also seen at two other locations in similar habitat at approximately the same elevation. The birds were taped and photographed by Lasley. On 3–4 June and again on 19 June, Lockwood reported twelve separate sightings of Flammulated Owl near the same general area.

Northern Saw-whet Owl (*Aegolius acadicus*).—On 3 June, Lockwood observed a Northern Saw-whet Owl in a pine/juniper woodland on the SE slope of Mt. Livermore. This species was observed for approximately 20 minutes and was photographed.

Olive-sided Flycatcher (*Contopus borealis*).—No published records are available for this species as a breeding bird. Summer sight records, however, do exist for this species in the higher elevations of the Davis Mountains. On 4 June, we observed six separate birds on a one mile stretch of road beginning about 2,300 m. On 8 June near the same location, Bryan observed a pair copulating to indicate probable breeding according to TBBAP criteria. The habitat was a steep slope with scattered conifers. The birds were photographed by Lasley.

Gray Flycatcher (*Empidonax wrightii*).—There is no indication of this species nesting in the state prior to the Webb and Howell observation of 1990. This

Fig. 2. This Gray Flycatcher's nest contained three nestlings, two of which are visible here. This photograph (TPRF #912E) is the first documented evidence of nesting Gray Flycatchers in the state. Photo by Kelly B. Bryan and Greg W. Lasley.

species was observed on every day of our stay and was generally observed between 1,850 and 2,150 m. Habitat for this bird varied from the more common pinyon/oak/juniper woodland to areas with scattered ponderosa pines in the higher elevations. In the Mt. Livermore and Mt. Locke quadrangles, 32 separate territories were mapped by Lasley. On 8 June, Bryan located a nest containing three nestlings being fed by a pair of adult birds. The documentation obtained by Lasley and Bryan represents the first photographed nesting record for this species in Texas (Figure 1 and Figure 2). Several other individuals were photographed and at least five different singing males were tape recorded. On 19 June, Lockwood observed a pair of Gray Flycatchers with recently fledged young on the south side of Mt. Livermore within the Paradise Mountain topographic quadrangle. His report was submitted independently of our survey. This species appears to have a stable population in at least a small area of the Davis Mountains, but much more work is needed to determine the range of this bird in Texas.

Dusky-capped Flycatcher (*Myiarchus tuberculifer*).—There are very few sight records of this species for the state of Texas and no previous indication of nesting. On 4 June, we observed two birds that appeared paired at an elevation of 2,450 m. The birds behaved in a territorial manner, but we could not locate a nest site. Although we could not relocate the birds on 7 June, Lockwood observed a singing Dusky-capped Flycatcher on 19 June less than one mile from our original obser-

vation location. The original pair of birds was taped and photographed by Lasley and Bryan.

Brown Creeper (*Certhia americana*).—On 27 June, Lockwood observed two Brown Creepers at 1,780 m elevation in a section of upper Limpia Canyon. The birds were in ponderosa pine. Although this species is resident in the Guadalupe Mountains, summer records from the Davis Mountains are rare.

House Wren (*Troglodytes aedon*).—There appear to be no previous summer records of this species in the Davis Mountains. On 6 and 7 June, we observed at least ten singing birds in two separate quadrangles at elevations above 2,150 m. Many of these birds appeared to have well defined territories. This species was tape recorded by Lasley.

Orange-crowned Warbler (*Vermivora celata*).—There are no nest records of this species in Texas outside the Guadalupe Mountains. On 8 June, Peterson observed a single bird in shrubbery from a distance of approximately 4 m at an elevation of about 2,500 m. The bird was carrying pine needles in its beak. At that time, the group was split up and no other observers saw the bird. The bird flew before any photographs could be made. The 1990 Webb and Howell sight observation of Orange-crowned Warbler was made at approximately the same location.

Virginia's Warbler (*Vermivora virginiae*).—Although scattered summer sight records exist for this species in the Davis Mountains, very little is known about its breeding range in Texas. Prior to this survey, it was considered a confirmed nester only in the Guadalupe Mountains. On 4 and 6 June, we observed four different singing birds in two different topographic quadrangles. Both locations were above 2,150 m on wooded slopes. One bird was observed at the same location on two different days. This species was taped and photographed by Lasley.

Yellow-rumped Warbler (*Dendroica coronata*).—This species was reported from the Davis Mountains by Webb and Howell in 1990 (Lasley and Sexton 1990). To date there are very few summer records outside the Guadalupe Mountains. We observed at least three Yellow-rumped (Audubon's) Warblers, two of which were singing males, at an elevation of approximately 2,300 m. The birds were observed in the same area on two different days, 4 and 8 June. The birds were taped by Lasley and photographed by Lasley and Bryan.

Green-tailed Towhee (*Pipilo chlorurus*).—There are a few scattered summer records for this species in the Davis Mountains. We observed at least six individuals at elevations ranging from 2,350 to 2,550 m near the summit of Mt. Livermore on 4 June. Many of these birds were singing and appeared to have well defined territories. At least three Green-tailed Towhees were seen again on 8 June at the same location. This species was taped and photographed by Lasley.

Red Crossbill (*Loxia curvirostra*).—No summer records exist for this species in the Davis Mountains. A pair of Red Crossbills was observed by Lasley on 5 June and again by Peterson on 7 June in the same area. The habitat included large ponderosa and limber pine and could have supported a nesting pair. These birds may prove to be rare or irregular nesters in the Davis Mountains. Both male and female crossbills were taped and photographed by Lasley.

Discussion

It seems unlikely that any of the bird species we report are recent arrivals due to habitat changes. Land use in a majority of the Davis Mountains range has been

governed by ranching for several generations. Grazing and/or browsing impact on vegetation in the higher elevations of the range, however, is minimal because ranch animals are not heavily stocked at those elevations. The montane woodland habitat appeared to be unaltered from previous studies, and the tree species we observed were of the same composition as reported by Wauer and Ligon (1974), Warnock (1977) and Powell (1988).

Annual rainfall patterns in the Davis Mountains may play a major role in the local distribution of certain species of birds. No published comparative studies are available, but fluctuating rainfall patterns and associated insect populations and seed crop availability can have an impact on breeding bird species diversity in the Trans-Pecos region. Grace's Warbler (*Dendroica graciae*), which was unusually common during our survey, may be an example of a species at a population peak due to above average rainfall during the previous growing season. The correlation of rainfall and species diversity should be considered a factor in our survey results. Prior to the late summer and fall of 1990, the Davis Mountains and Trans-Pecos region had experienced a drought period lasting approximately five years.

The majority of habitat in the Mt. Livermore quadrangle is private property accessible only by foot or four-wheel drive vehicle, including all of the habitat we surveyed. Many of the bird species observed by Webb and Howell in 1990 (Lasley and Sexton 1990) and by the authors in 1991 likely went unreported for many years for this reason. Flammulated Owl, Northern Saw-whet Owl, Dusky-capped Flycatcher, House Wren, Virginia's Warbler, Orange-crowned Warbler, Yellow-rumped Warbler and Green-tailed Towhee were seen only in steep terrain at elevations above 2,200 m. As nesting birds, the above species may be specific to only the highest elevations in the Davis Mountains.

Of the species considered here for status change, Gray Flycatcher appeared to be the most widespread. In the quadrangles we surveyed, this bird was common in appropriate habitat. Surprisingly, it was the species with the fewest Texas sight records of all birds recorded on this survey other than the Dusky-capped Flycatcher and Northern Saw-whet Owl. A natural area survey in 1973 (LBJ School of Public Affairs 1973) included reports of *Empidonax* flycatchers in the Mt. Livermore area but considered the precise species unidentifiable. Oberholser and Kincaid's *The Bird Life of Texas* (1974), the *T.O.S. Checklist of the Birds of Texas, Second Edition* (Arnold 1984), and *The AOU Checklist of North American Birds, Sixth Edition* (1983) all consider Gray Flycatcher a migrant in the Trans-Pecos of Texas and give no indication of breeding.

Given the accessibility problems associated with the appropriate Davis Mountains habitat and the difficulty of *Empidonax* identification. we suggest that Gray Flycatcher probably has been an overlooked nester in Texas. Its exact range in Texas and the Davis Mountains, however, remains unknown. Nesting habitat does exist for this species in other mountains in the Trans-Pecos, but there are no summer sight records that would suggest a possible nesting location outside the Davis Mountains. Wauer's extensive work on the avifauna in the Chisos Mountains (Wauer 1985) coupled with the abundance of birdwatchers frequenting Big Bend National Park make the montane habitat in that mountain range an unlikely area for a nesting Gray Flycatcher to escape notice. The Guadalupe Mountains also have potential in terms of Gray Flycatcher habitat (Newman

1975) but scattered sightings of lone individuals in the Park have, to date, indicated migrating birds only (Newman and Flippo, 1991).

Summary

Some of the bird species recorded during our survey have been previously observed during the summer months in the higher elevations of the Davis Mountains. Olive-sided Flycatcher, Virginia's Warbler, Yellow-rumped Warbler and Green-tailed Towhee have been observed on at least one occasion in montane habitat during the nesting season prior to 1990. Written records of the above species, however, were not available previously and, as such, were not included in the information database of Texas ornithology. Other species such as Northern Saw-whet Owl, Gray Flycatcher, Dusky-capped Flycatcher, House Wren, Orange-crowned Warbler and Red Crossbill lack any known documentation from the Davis Mountains during the nesting season.

More seasonal studies are needed to determine the status and distribution of the Davis Mountains avifauna. The montane woodland in the Trans-Pecos provides specialized habitat for many species of birds. The Davis Mountains have more surface area above 1,700 m than either the Chisos or the Guadalupe Mountains (Wauer and Ligon 1974), yet far less is known about the avifauna in the Davis Mountains than in the other two major Texas mountain ranges.

"The authors would like to remind readers that all surveyed property in this article is currently private property and not available for birdwatching or any recreational use."

Birds Observed in the Davis Mountains Montane Woodland, 1–8 June 1991

The following information includes observations from the Mt. Livermore, Mt. Locke and Paradise Mountain topographic quadrangles.

Column 1 = Number of days recorded
Column 2 = Greatest daily total
X = Possible nester according to TBBAP criteria
P = Probable nester according to TBBAP criteria
C = Confirmed nester according to TBBAP criteria

* More information needed to determine breeding status within the Davis Mountains.
# Pre-1991 breeding records either do not exist or are based only on summer sight records for the Davis Mountains.
+ Pre-1991 breeding records are not well documented or are based on marginal populations for the Davis Mountains.

	1	2	
Turkey Vulture (*Cathartes aura*)	7	30	P
Cooper's Hawk (*Accipiter cooperii*)	4	1	P
Common Black-Hawk (*Buteogallus anthracinus*)+	2	2	P

Zone-tailed Hawk (*Buteo albonotatus*)	3	1	P
Red-tailed Hawk (*B. jamaicensis*)	5	3	P
American Kestrel (*Falco sparverius*)	1	1	X
Prairie Falcon (*Falco mexicanus*)	1	1	X
Wild Turkey (*Meleagris gallopavo*)	4	12	C
Montezuma Quail (*Cyrtonyx montezumae*)	2	10	P
Band-tailed Pigeon (*Columba fasciata*)	5	13	P
White-winged Dove (*Zenaida asiatica*)	4	7	P
Mourning Dove (*Z. macroura*)	5	37	C
Flammulated Owl (*Otus flammeolus*)#	2	4	P
Western Screech-Owl (*Otus kennicottii*)	2	2	P
Great Horned Owl (*Bubo virginianus*)	1	1	X
Northern Saw-whet Owl (*Aegolius acadicus*)*	1	1	?
Common Nighthawk (*Chordeiles minor*)	7	2	P
Common Poorwill (*Phalaenoptilus nuttallii*)	4	2	P
Whip-poor-will (*Caprimulgus vociferus*)+	2	15	P
White-throated Swift (*Aeronautes saxatalis*)	6	18	C
Magnificent Hummingbird (*Eugenes fulgens*)+	1	4	C
Black-chinned Hummingbird (*Archilochus alexandri*)	4	2	P
Broad-tailed Hummingbird (*Selasphorus platycerus*)	4	13	P
Acorn Woodpecker (*Melanerpes erythrocephalus*)	7	6	C
Ladder-backed Woodpecker (*Picoides scalaris*)	6	6	P
Northern Flicker (*Colaptes auratus*)	7	4	C
Olive-sided Flycatcher (*Contopus borealis*)#	4	6	P
Western Wood-Pewee (*C. sordidulus*)	7	23	C
Gray Flycatcher (*Empidonax wrightii*)#	7	14	C
Cordilleran Flycatcher (*E. occidentalis*)+	2	2	P
Black Phoebe (*Sayornis nigricans*)	2	2	C
Say's Phoebe (*S. saya*)	7	2	C
Dusky-capped Flycatcher (*Myiarchus tuberculifer*)*	1	2	?
Ash-throated Flycatcher (*M. cinerascens*)	7	11	C
Cassin's Kingbird (*Tyrannus vociferans*)	7	9	C
Violet-green Swallow (*Tachycineta thalassina*)	7	34	C
Barn Swallow (*Hirundo rustica*)	5	5	C
Steller's Jay (*Cyanocitta stelleri*)	4	10	P
Scrub Jay (*Aphelocoma coerulescens*)	6	4	C
Common Raven (*Corvus corax*)	7	3	P
Mountain Chickadee (*Parus gambeli*)	6	19	C
Tufted Titmouse (*P. bicolor*)	7	18	C
Bushtit (*Psaltriparus minimus*)	7	42	C
Brown Creeper (*Certhia americana*)#	1	2	X
White-breasted Nuthatch (*Sitta carolinensis*)	7	37	C
Pygmy Nuthatch (*S. pygmaea*)	1	1	X
Rock Wren (*Salpinctes obsoletus*)	4	5	C
Canyon Wren (*Catherpes mexicanus*)	5	2	P
Bewick's Wren (*Thryomanes bewickii*)	6	6	P
House Wren (*Troglodytes aedon*)#	2	6	P
Western Bluebird (*Sialia mexicana*)	7	8	C
Hermit Thrush (*Catharus guttatus*)	3	3	P
American Robin (*Turdus migratorius*)+	3	7	C
Northern Mockingbird (*Mimus polyglottos*)	3	2	P
Curve-billed Thrasher (*Toxostoma curvirostre*)	1	1	X
Loggerhead Shrike (*Lanius ludovicianus*)	1	1	X
Solitary Vireo (*Vireo solitarius*)	6	22	C
Hutton's Vireo (*V. huttoni*)	6	6	C
Warbling Vireo (*V. gilvus*)+	1	5	C
Orange-crowned Warbler (*Vermivora celata*)#	1	1	C
Virginia's Warbler (*V. virginiae*)#	3	2	P

Yellow-rumped Warbler (*Dendroica coronata*)#	2	3	P
Grace's Warbler (*D. graciae*)	5	23	C
Hepatic Tanager (*Piranga flava*)	7	22	C
Western Tanager (*P. ludoviciana*)	7	8	C
Black-headed Grosbeak (*Pheucticus melanocephalus*)	6	23	C
Blue Grosbeak (*Guiraca caerulea*)	1	1	X
Green-tailed Towhee (*Pipilo chlorurus*)#	2	6	P
Rufous-sided Towhee (*P. erythrophthalmus*)	6	38	C
Canyon Towhee (*P. fuscus*)	4	2	C
Rufous-crowned Sparrow (*Aimophila ruficeps*)	3	3	P
Chipping Sparrow (*Spizella passerina*)	7	12	C
Black-chinned Sparrow (*S. atrogularis*)	2	3	P
Lark Sparrow (*Chondestes grammacus*)	4	2	P
Black-throated Sparrow (*Amphispiza bilineata*)	1	1	X
Brown-headed Cowbird (*Molothrus ater*)	7	28	P
House Finch (*Carpodacus mexicanus*)	8	7	C
Red Crossbill (*Loxia curvirostra*)#	2	2	P
Lesser Goldfinch (*Carduelis psaltria*)	4	6	P

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SHORT COMMUNICATIONS

Recent Literature About Texas Birds

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Edwin C. Davis, Egg Collector and Publisher in Cooke County, Texas

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Egg collecting during the late 1800's was often practiced exclusively as a hobby. There were, however, a few practitioners of this activity in Texas who, through their publications, made a contribution to our knowledge of birds. One of the more productive of these individuals was E. C. Davis, publisher of *The Sunny South Oologist* (Casto 1973).

E. C. Davis, son of Edward R. Davis, was born in Marshall, Texas, on 18 March 1864. By 1880, the Davis family was living in Gainesville, Cooke County, where Edwin worked first in a printing office and later as a clerk in a dry goods store. His plan to publish an oological journal was revealed in January 1886 when he asked G. H. Ragsdale if he would prepare a manuscript for the first issue (Davis 1886). Only three issues (March, April, and May 1886) of the *The Sunny South Oologist* were published. A fire destroyed the Davis home along with all copies of the journal, addresses of subscribers, financial records, and specimens (Dorsey 1977). In spite of this disaster, Davis continued to collect and to publish a series of short notes as well as sending reports to the USDA, Division of Economic Ornithology (see Bibliography). His descriptions of the nesting habits of the Wild Turkey, White-tailed Hawk, Scissor-tailed Flycatcher, and Bell's Vireo are included in Davie's *Nests and Eggs of North American Birds* (1889). Perhaps Davis' most important contribution was his reports of the Carolina Parakeet in Lamar, Brown, and Red River counties which were used by Oberholser (1974) in reconstructing the history of this species in Texas.

In 1895, Davis published his *Standard Collectors' Directory* which reportedly contained the names of nearly 1,000 ornithologists and oologists. No copy of this rare directory has yet been located and its existence is known only from the announcements of its preparation and publication (Anon. 1895; Davis 1895). Sometime around 1899, Davis made the decision to abandon oology. He offered his egg collection of 768 species and subspecies for sale and left Gainesville for San Diego, California, in early 1900.

Davis' activities in California are unknown, but by 1913 he was living in Baton

Rouge, Louisiana. From 1917 until 1940, he served as the extension bee specialist for Louisiana becoming widely known throughout the state as "Honey Boy" Davis. He died in Baton Rouge on 27 January 1943 and was remembered by his colleagues as the "father" of modern bee culture in Louisiana (Bateman 1935; Bolton 1991; Williamson 1951).

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Acknowledgments

I would like to thank George Andrew Dorsey of Rome, Georgia, for sharing his recollections of E. C. Davis. Judy Bolton, public services librarian at Hill Memorial Library, LSU, provided information on Davis' career as an extension agent in Louisiana. Lynda Garrett, librarian at the Patuxent Wildlife Research Center, graciously supplied copies of Davis' reports to the Division of Economic Ornithology. This study was supported by a summer development leave granted by the University of Mary Hardin-Baylor.

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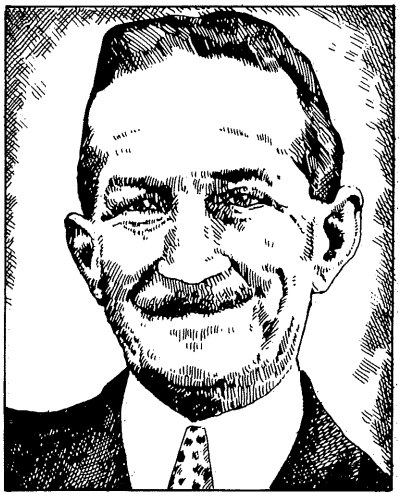
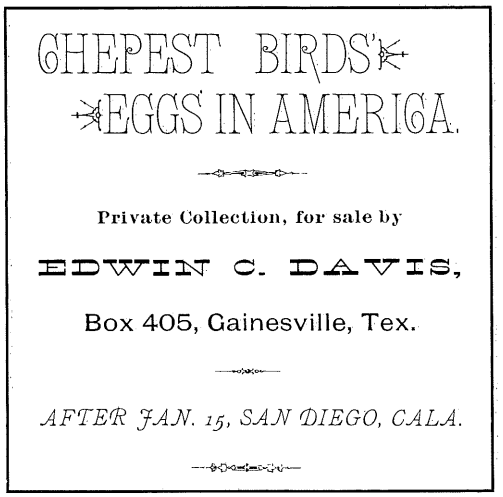


Edwin C. Davis



Cover of the brochure advertising sale of the Davis Collection

Does the Cedar Waxwing Nest in the Texas Panhandle?

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The southern limit of the breeding range of the Cedar Waxwing (*Bombycilla cedrorum*) in the central United States is in Colorado, western Oklahoma, Kansas, and central Missouri (AOU 1983). Accumulated observations of juvenal-plumaged birds, as well as adults, during the late summer and early fall now point to the possibility of the waxwing nesting farther south in the Texas Panhandle.

The latest of these observations is of a flightless juvenal-plumaged bird found on 19 October 1989 by Thomas L. Johnson on the ground in the yard of Rosalie Johnson, 1801 Boyd Street, Borger, Hutchinson County, Texas. The juvenile was accompanied by two adult waxwings. Mrs. Johnson states she had seen waxwings in the neighborhood for at least a month prior to the 19 October discovery. The juvenile died subsequently and was deposited in the Texas Cooperative Wildlife Collections at Texas A&M University (TCWC #12717). An examination of the specimen indicated the flight feathers were fully grown; however, the preparation showed no injury that might have been responsible for the bird's inability to fly (*fide* Keith Arnold).

A review of the records on file with the Texas Panhandle Audubon Society discloses other late summer and early fall sightings of juvenile Cedar Waxwings in the area: two in Amarillo, Potter County, 13 September 1959 (P. Acord); one in Amarillo, Potter County, 20 August 1968 (P. Acord); two together at Buffalo Lake National Wildlife Refuge, Randall County, 23 September 1970 (K. Seyffert); one with an adult at BLNWR, Randall County, 24 September 1972 (K. Seyffert); one in Amarillo, Potter County, 29 September 1974 (K. Seyffert); five together in Amarillo, Potter County, 17 August 1985 (P. Acord); three in the Palo Duro Canyon State Park, Randall County, 19 September 1991 (K. Seyffert). In addition, adults alone have been observed: one in Amarillo, Potter County, 1 September 1979 (K. Seyffert); one in Wolf Creek Park, Ochiltree County, 13 September 1981 (K. Seyffert); one at BLNWR, Randall County, 19 September 1982 (K. Seyffert); one at BLNWR, Randall County, 27 September 1985 (K. Seyffert).

Little is known about the post-breeding dispersal of Cedar Waxwings. If the Borger bird and the other Panhandle sightings of juveniles were not products of local nestings, then from where could they possibly have originated? The nearest area of confirmed nestings are those in the Oklahoma Panhandle near Kenton, Cimarron County, and Gate, Beaver County (Sutton 1967), the former site approximately 75 km and the latter 70 km from Borger. The nearest confirmed Colorado breeding sites are those in the southeastern sector in the Las Animas and Trinidad latilongs (Chase et al. 1982). There have been occasional sightings of juveniles in New Mexico, but without proof of nesting (Hubbard 1978).

The Cedar Waxwing is not a species commonly found in the Texas Panhandle in late summer or early fall. In many years it may not be seen at all and it rarely occurs in significant numbers until late winter or early spring. My records reflect

Table 1. Dates of early fall observations as compared to dates Cedar Waxwings were first seen the following winter.

First recorded (Sept–Nov)	Next recorded
28 Sep 1968 (1)	10 Mar 1968 (heard)
none	16 Jan 1970 (75)
23 Sep 1970 (2)	3 Jan 1971 (51)
none	20 Jan 1972 (15)
24 Sep 1972 (2)	21 Jan 1973 (2)
none	26 Jan 1974 (1)
24 Sep 1974 (1)	29 Dec 1974 (5)
23 Sep 1975 (3)	4 Jan 1976 (14)
19 Sep 1976 (3)	19 Dec 1976 (21)
18 Sep 1977 (2)	29 Jan 1978 (2)
none	11 Mar 1979 (8)
1 Sep 1979 (1)	21 Feb 1980 (heard)
23 Nov 1980 (40)	14 Dec 1980 (2)
13 Sep 1981 (1)	1 Jan 1982 (3)
19 Sep 1982 (1)	30 Dec 1982 (60)
25 Sep 1983 (1)	2 Jan 1984 (11)
22 Sep 1984 (1)	17 Jan 1985 (11)
6 Oct 1985 (1)	15 Dec 1985 (10)
27 Sep 1986 (1)	11 Jan 1987 (2)
28 Oct 1987 (1)	1 Jan 1988 (31)
none	29 Jan 1989 (11)
26 Nov 1989 (7)	1 Jan 1990 (10)
21 Nov 1990 (3)	10 Jan 1991 (6)

this phenomenon (Table 1). On average, three months elapse from the time the first waxwing is recorded in late summer or fall until one is seen again.

What factors are there to support the possibility that these sightings of juveniles are of birds fledged in the area? The Cedar Waxwing is known as a late nester, with egg incubation as late as 27 September (Bent 1950). Studies of breeding activity in Wisconsin, Michigan, and New York (Leck and Cantor 1979) show a 16–30 June breeding peak with a suggestion of a second peak in nest initiation at the end of July continuing into mid-August and later. The authors, however, caution against concluding from such data that the waxwing is double-brooded (Crouch 1936). Their studies of nesting data (1894–1970) discloses only 36% of the nests were started after 15 July; however, the post-1970 years show a marked change with 44% of the nests begun after 24 July. They doubt that broad climatic changes are responsible for the shift and suggest that the frequent parasitizing of the waxwing by the Brown-headed Cowbird (*Molothrus ater*) (Rothstein 1976) during the cowbird breeding peak in June may be causing the later nest initiations.

The length of egg incubation of the Cedar Waxwing is 10–16 days with a nesting period of 14–18 days (Ehrlich et al. 1988). Assuming median days of 12 and 16, the flightless Borger bird of 19 October would be within the time frame of being a product of local nesting, with egg incubation beginning 22 September.

The Cedar Waxwing nests irregularly over a wide range and its presence is dependent on the supply of berries or fruits that form the principal items in its diet (Bent 1950). It nests in a variety of trees and shrubs (Rothstein 1971). The habitat of the Borger bird appears to fulfill the species nesting requirements. The 45-year-old neighborhood has many large trees, located on the outskirts of town

near open fields, including elm (*Ulmus* sp.), cedar (*Juniperus* sp.) and other evergreens, and locust (*Robinia* sp.), with a wide variety of shrubs, including Pyracantha.

Factors that militate against this interpretation of possible nesting are the possibility that the flightless juvenile found in Borger may have been an ill bird, and the absence of reports of summering adults in the area. There have been numerous sightings of adult waxwings through the end of May, but the only subsequent one is a report of several at Lake Tanglewood, Randall County, 1 June 1981 (P. Acord).

Based on such evidence, it appears possible that the Cedar Waxwing nests in the Texas Panhandle; close observation should disclose confirmation.

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NOTES AND NEWS

Information for Contributors

ATTENTION AUTHORS.—The *Bulletin of the Texas Ornithological Society* is a semi-annual journal which publishes original research reports and short communications in the field of ornithology. Articles on a wide range of subjects are accepted, including documentation of new Texas records, interpretations of laboratory and field studies, historical perspectives on Texas ornithology, and developments in theory and methodology. Although the emphasis is on Texas birds, the *Bulletin* accepts papers which advance the knowledge of birds in general.

Manuscripts, including tables, should be typed and double-spaced on one side of 8½ × 11 inch (22 × 28 cm) white paper. Allow 3 cm margins on all sides. Manuscripts may be printed using a high-resolution dot-matrix or letter-quality printer. The last name of the first author must be at the top of each page of the manuscript and on the back of every figure. Submitted articles should follow the format observed in this and subsequent issues of the *Bulletin of the Texas Ornithological Society*. Feature articles should include an abstract and a "Literature Cited" section. Short Communications do not need an abstract.

Scientific and common names of North American birds must follow the 1983 A.O.U. Check-list and supplements. The 24-hour clock (0730), the continental dating convention (3 January 1989), and the metric system should be used.

Submit an original and two complete copies of the manuscript. Each manuscript will be subject to editing and will normally be reviewed by at least two persons who are knowledgeable in the subject. The reviewers will provide the editor with advice on the article's acceptability and accuracy. If the article passes review and is correct in form, it will be scheduled for publication. A voluntary page charge of $35 per printed page will be assessed. Payment of complete page charges will normally result in earlier publication. Accepted articles will be published on a "space available" basis if the page charges are not paid. Authors will be sent proofs of their articles prior to the final printing; information on ordering reprints will be supplied at that time.

Articles, reports and other items submitted for inclusion in the *Bulletin* should be sent to the editor, Karen L. P. Benson, Department of Wildlife & Fisheries Sciences, Texas A&M University, College Station, Texas 77843-2258.

ARTISTS.—The *Bulletin* encourages submission of original artwork and photographs of Texas birds to be used on the inside front cover of the publication. Send art and photos to Karen L. P. Benson, Department of Wildlife & Fisheries Sciences, Texas A&M University, College Station, Texas 77843-2258.

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BULLETIN
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TEXAS ORNITHOLOGICAL SOCIETY

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