

VOCALIZATIONS OF THE PURPLE MARTIN

CHARLES R. BROWN

ABSTRACT.—Ten types of vocalizations of Purple Martins (*Progne subis*) from Texas and Arizona were described and compared. Solitary-nesting martins in Arizona did not possess greater vocal repertoire sizes than martins nesting colonially in Texas, which suggests that vocal repertoires are not evolutionarily plastic and have not changed with recent shifts toward coloniality in Texas birds. Some vocalizations differed markedly in structure between these populations, documenting for the first time, geographical vocal variation in the Hirundinidae. A re-examination of subspecific affinities of Purple Martins in Arizona seems warranted on the basis of voice; birds in mountain forests have vocalizations similar to those of birds in deserts, and both differ from the eastern nominate race. Purple Martins possess a greater vocal repertoire than do more colonial swallows, probably because historically they have been largely solitary and lacked acoustical constraints on the evolution of vocal repertoires.

The Purple Martin (*Progne subis*) is a widespread North American swallow, nesting in backyard birdhouses in the eastern parts of its range and in remote high mountain forests and deserts in the West. Its breeding biology and behavior have received considerable research attention (Allen and Nice 1952; Johnston and Hardy 1962; Finlay 1971; Niles 1972; Brown 1978a, b, 1979, 1980; Brown and Bitterbaum 1980), but, aside from brief comments by Johnston and Hardy (1962), its vocalizations have not been described.

This study was undertaken with three objectives. First, I sought to test the hypothesis (Brown 1983, in press) that solitary swallows have larger vocal repertoires than colonial species. Purple Martins, at least before the recent advent of birdhouses, were largely solitary, nesting primarily in abandoned woodpecker holes. Following Brown (1983, in press), one might expect larger vocal repertoires in martins than in more colonial species such as the Cliff (*Hirundo pyrrhonota*) or Bank (*Riparia riparia*) swallows. This study examined repertoire size in martins. Second, I examined whether either call structure or repertoire size differ among populations of Purple Martins inhabiting different geographical regions and exposed to different selective pressures. Martins nesting in suburban backyards in Texas, often in colonies of up to 50 pairs, were compared with birds nesting solitarily in mountain forests of Arizona. If martins in Arizona have larger vocal repertoires than those in Texas, this could mean that vocal repertoire size is evolutionarily plastic, possibly having changed with the recent shift toward coloniality in Texas birdhouse populations. Differing social structures could be very important in the evolution of geographical variation in avian vocal-

izations. Lastly, I wished to catalog and describe vocalizations for a genus about whose vocal communications nothing had been reported.

STUDY SITES, METHODS, AND TERMINOLOGY

I conducted this study in Sherman, Grayson County, north central Texas, and in the Chiricahua Mountains, Cochise County, southeastern Arizona. In Texas, most work was done from 1970 to 1979 at one colony (elevation 238 m) consisting of up to seven birdhouses (see Brown 1979, 1980 for details on study areas and how individual martins were recognized), with all actual recording done 5–22 April 1980 and 11–22 July 1980. In Arizona, martins were studied in 1980 at nesting sites in woodpecker holes of dead snags at Rustler Park (elevation 2,545 m) and near Herb Martyr Lake (elevation 1,924 m), both in the Chiricahuas, with all actual recording done 11–24 June.

Field recordings were made with Uher 4000 Report L and 4000 Report 1C tape recorders and Uher M517 and Electrovoice Soundspot microphones, the former mounted in a 60-cm parabolic reflector. Tape speeds were 19 and 9.5 cps. Sonograms were made on a Kay Electronics Sona-Graph Model 6061-B using wide band pass setting and linear scale.

Following Thorpe (1961) and Brown (in press), I used the following bioacoustical definitions: *figure*, a continuous tracing on a sonogram; *syllable*, any single figure or any two figures lasting 50 msec or less; *song*, a series of sounds of more than one type, uttered in succession and forming a recognizable sequence or pattern in time; *subsong*, an irregular and ill-defined series of syllables of lower in-

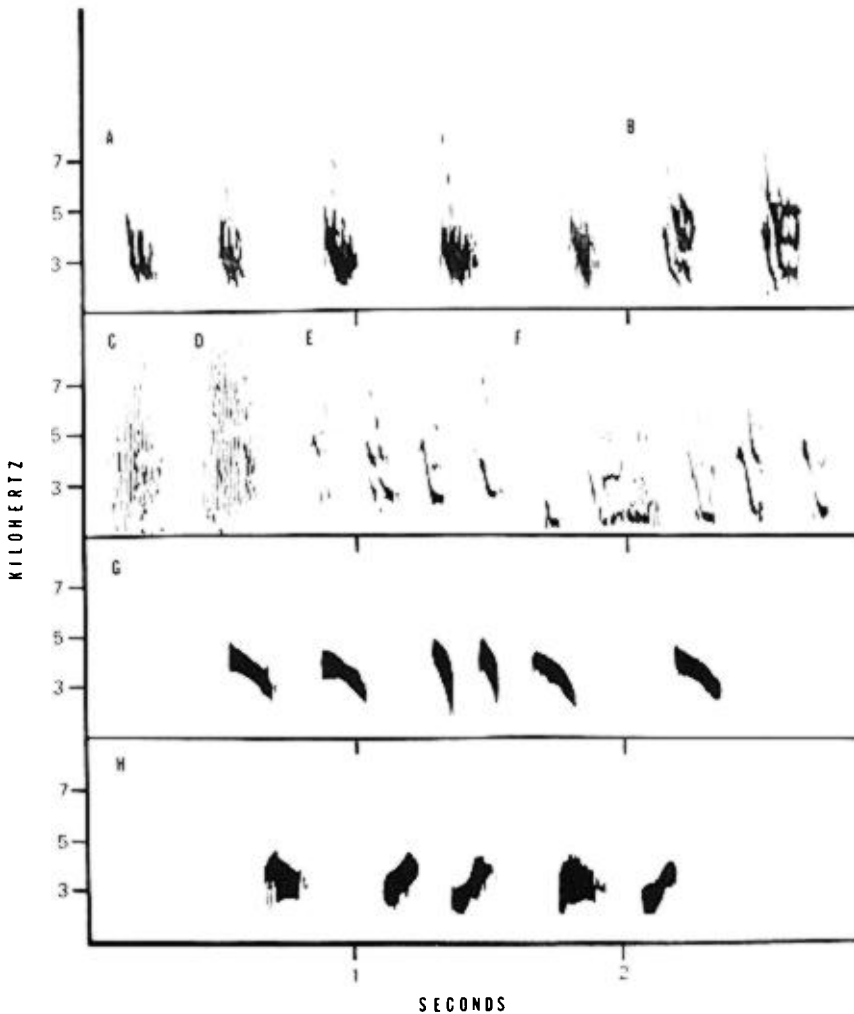


FIGURE 1. Sonograms of Purple Martin vocalizations: A, five juvenile calls, each from 36 day-old individuals of different broods; B, two *choo* calls, each from different individuals; C, a Texas *zwrack* call; D, an Arizona *zwrack* call; E, series of Texas *hee-hee* calls from one individual; F, series of Arizona *hee-hee* calls from one individual; G, series of Arizona *zweet* calls from one individual; H, series of Texas *zweet* calls from one individual.

tensity than true song but nevertheless with a recognizable pattern; *call*, a discrete sound, usually not a component of a sequence within a song.

Examples of each type of vocalization described herein have been deposited in the Library of Natural Sounds, Laboratory of Ornithology, Cornell University, Ithaca, New York.

RESULTS

JUVENILE CALLS

Calls given by juvenile martins at the time of fledging had a frequency range of about 2 to 4 kHz (Fig. 1A). The call was monosyllabic and lasted about 125 msec. Essentially identical calls were given by all juveniles still in the nest after about 24 days of age. (Purple Martins

fledge at 28 days.) All recordings of juvenile calls came from Texas martins, but Arizona birds also possessed them.

Juvenile calls (the *choo-choo* calls of Brown 1978a) were given most often by birds in the nest whenever parents arrived to feed them, although young birds also uttered them whenever a nonparental bird came near. On their initial flights, fledglings called repeatedly and continued to do so until they were established in a grouping area (Brown 1978a) away from the colony. Once in a grouping area the juveniles were largely silent until a parent or other martin appeared. They generally gave this call whenever they were moving to and from certain locations or when harassed by raiders (Brown and Bitterbaum 1980). These calls did not discourage the raiders but attracted parents' attention, enabling the parents to

defend the juveniles. When frightened by me or predators and when parents gave *zweet* alarm calls (see below), juveniles in the nest and in grouping areas became silent.

CHOO CALLS

Choo calls (Fig. 1B), given by females while leading their broods, were recorded only from Texas martins, but Arizona birds likely also possess them. This monosyllabic call was structurally similar to the *cher* call (see below), although it was (to my ear) qualitatively different. Its frequency range was 1.5 to 5 kHz, with harmonics especially in the latter part of the call, and lasted about 140 msec. Series of *choo* calls, with calls separated by intervals of 0.3 to 1 or more s, were recorded.

Choo calls, heard only from female martins, were recorded most often as females led their broods back to the nesting houses near dusk. They uttered these calls almost constantly while their young were flying nearby and used it to "announce" that it was time to return to the nesting houses (Brown 1978a). Females also gave *choo* calls when their young were fledging from the nest and as they were leading them to grouping areas on the day of fledging or on subsequent days. Females always ceased giving these calls after all their young had reached either the nesting house or the grouping area, which suggests that the call has a leadership function. I never heard *choo* calls given in any other context. *Cher* and *zweet* calls (see below) were sometimes interspersed with *choo* calls. I do not know if male Purple Martins give *choo* calls.

ZWRACK CALLS

Zwrack calls were used in high intensity alarm and aggressive interactions (Fig. 1C and 1D). This call ranged in frequency from 1 to above 8 kHz and had a duration of about 180 msec. These calls showed no structural differences between Texas and Arizona martins.

Zwrack calls were used mainly in interspecific interactions. When martins attacked or mobbed fox squirrels (*Sciurus niger*), Acorn Woodpeckers (*Melanerpes formicivorus*), cats, people, or (rarely) House Sparrows (*Passer domesticus*) and European Starlings (*Sturnus vulgaris*) near their nests, they gave *zwrack* calls. These attacks consisted of low swoops at the intruder ("dive-bombing"), and as a martin passed closest to the intruder, the *zwrack* was given. *Zweet* calls (see below) often accompanied these attacks also. The *zwrack* call was given only singly, and I recorded no series of them. The *zwrack* call indicated high intensity alarm, because an intruder had almost to enter a nest before martins would attack and use this

vocalization. Both males and females gave *zwrack* calls. The context of these calls did not differ between Texas and Arizona birds.

On rare occasions mature martins uttered *zwrack* calls while harassing fledglings near the nesting colony. These raiders perched near (or on) the juveniles and attempted to knock them off the wire or tree branch (see Brown and Bitterbaum 1980). Sometimes the fledglings briefly resisted the raiders, and the raiders gave *zwrack* calls while grappling with the young birds. *Zwrack* calls in this context, however, were not frequent.

HEE-HEE CALLS

A vocalization related to territorial defense was the *hee-hee* call (Fig. 1E and 1F). Texas and Arizona *hee-hee* calls had a frequency range of 2 to 4 kHz and 1.5 to 4 kHz, respectively, with some slight harmonic overtones reaching 7 kHz and 6 kHz, respectively. Both Texas and Arizona *hee-hee* calls had a duration of about 100 msec. Series of four to ten *hee-hee* calls uttered at intervals of about 80 msec were common. I heard few single *hee-hee* calls.

Hee-hee calls were often given by male Purple Martins during intense intraspecific combat. When two birds were fighting over a territory or a boundary, they would fall off the nesting houses, grappling in flight. Upon hitting the ground and separating, both birds would frequently return to the house, enter rooms, and invariably give *hee-hee* calls. Residents often uttered *hee-hee* calls for several minutes after repelling an intruder successfully.

On occasion, males also gave *hee-hee* calls while attracting females via a Claiming-Reclaiming Display (Johnston and Hardy 1962) as they entered rooms. In this display, flying males "got the attention" of females flying over the colony, and the females followed the males to their territories. The males always immediately entered a room upon arriving at the birdhouse, and often females followed them into rooms. The *hee-hee* call in these circumstances possibly reflected males' conflicting drives of mate attraction and territorial defense. Arizona martins nesting in woodpecker holes exhibited the same behavior.

Females were generally silent when they defended their territories from other females, although occasionally they gave calls (which I did not succeed in recording) similar to the *hee-hee* during fights.

ZWEET CALLS

Zweet calls (Fig. 1G and 1H) had a dual nature: to indicate high intensity alarm and to indicate high intensity intraspecific excitement. This call

was monosyllabic, and both Arizona and Texas calls possessed a frequency range of 2 to 4.5 kHz. *Zweet* calls from Texas lasted about 140 msec, were uttered in variable sequences of 0.1 to 1 s intervals with no pattern, and were slightly upslurred at the end. Arizona calls had a duration of about 170 msec, had a consistently recurring pattern of three syllables as shown in the middle of Figure 1G, and were noticeably downslurred at the end. The three-syllable pattern consisted of two short (85 msec) syllables separated by an equal pause, and a longer (170 msec) syllable separated from the other two by a 125-msec interval. Arizona *zweet* calls not part of this pattern occurred at intervals of 0.2 to 1 s. The three-syllable pattern was used in virtually all Arizona sequences containing more than four *zweet* calls, and was highly distinct.

Texas and Arizona Purple Martins used *zweet* calls whenever they were aroused or alarmed. Animals eliciting *zweet* calls from mature Texas martins included the birds mentioned in Brown (1978a) plus Sharp-shinned Hawks (*Accipiter striatus*), fox squirrels, box turtles (*Terrapene carolina*), dogs, cats, and people. Goshawks (*A. gentilis*) and Acorn Woodpeckers elicited these calls from Arizona martins. *Zweet* calls were typically given in flight as the birds flew away, circled nearby, or perched above a terrestrial nest predator. The usual effect of *zweet* calls was to cause other colony members to either fly away or become very alert. Both male and female martins gave *zweet* calls.

Zweet calls were also frequently used in high intensity intraspecific interactions and most often when resident birds in Texas colonies spotted new arrivals in the colony. Mated males in particular gave rapid and intense *zweet* sequences when new unmated females appeared in the colony and entered their territories. (Interestingly, unmated males did not give prolonged *zweet* calls at that time.) These calls possibly served to alert a male's mate that a female intruder was present.

Mated males gave *zweet* calls whenever they saw other males attempting to forcibly copulate with their mate (Brown 1978b) or sometimes simply if they saw another male near their mate. In these situations, *zweet* calls accompanied the mated male's attempt to drive the other male away from the female. *Zweet* calls were sometimes given while two birds (males or females) were engaged in territorial fights inside a nesting cavity; although I am not certain, I believe that the loser in these fights gave *zweet* calls (possibly as false alarm calls) when trying to shake the grasp of the winner. In addition, *zweets* were given in other

situations in which the context was unclear, but in all cases it was when the birds were seemingly aroused by something. There seemed to be little contextual difference in *zweet* calls between Texas and Arizona martins.

Despite the dual nature (predator alarm and conspecific arousal) of the *zweet* call and the fact that calls in these two categories were structurally identical, there appeared to be no ambiguity on the part of the receivers. Whenever, for instance, *zweet* calls were given by fighting birds or in response to a conspecific intruder, other martins in the colony continued their activities and did not respond to the *zweet* calls at that time as alarm calls, whereas *zweet* calls given as alarm influenced all birds in the colony to behave accordingly.

CHER CALLS

The most common and most generalized vocalizations of the martins were *cher* calls (Fig. 2A and 2B). Texas *cher* calls were generally monosyllabic, possessed a frequency range of 1.5 to 5 kHz, and lasted about 125 msec with some harmonics. Arizona *cher* calls were either mono- or disyllabic, fell between 1 and 5 kHz, and usually lasted about 125 msec but with some birds up to 225 msec. Arizona *cher* calls also showed slight harmonics. In both Texas and Arizona birds, *cher* calls were given in sequences with intervals of 0.125 to 1 s or longer between calls. They were only occasionally given singly and usually at least two were uttered at a time.

Cher calls were used by Purple Martins in virtually all situations. They were often used in contexts suggesting that they served as contentment calls, but they were also given when birds seemed excited by something. *Cher* calls were usually accompanied by noticeable flips or shakes of the body and wings. In times of alarm, *cher* calls were interspersed with *zweet* and *zwrack* calls. *Cher* calls were also prevalent during courtship and constituted part of the Texas males' croak songs. *Cher* calls were given by both sexes, in flight and at rest. Series of *cher* calls comprised the "greeting" vocalizations (Brown 1979) given by neighboring birds when approaching each other at a birdhouse.

Although *cher* calls occurred often in daylight hours, these calls were also prevalent at predawn in Texas colonies. They typically began about 04:00 CDT, continuing until dawn, and were given both by birds inside the birdhouses and by ones flying nearby. The only vocalizations I heard in the predawn hours were *cher* and chortle calls, and croak and chortle songs (see below). Nocturnal calling often seemed contagious, for when one bird in

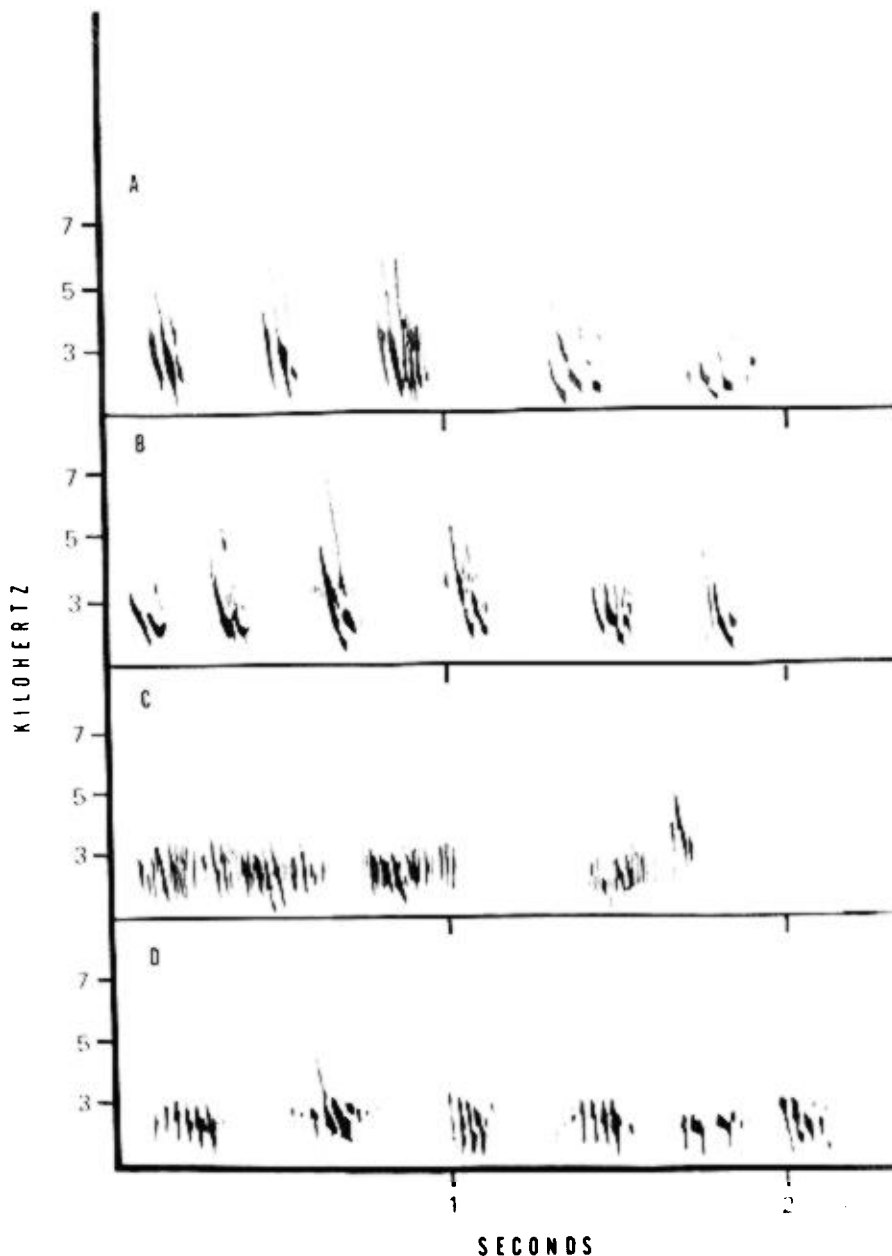


FIGURE 2. Sonograms of Purple Martin vocalizations: A, Arizona *cher* calls, each from different individuals; B, Texas *cher* calls, each from different individuals; C, Arizona chortle calls from two individuals; D, Texas chortle calls, each from different individuals.

a room (or house) started calling, others nearby also began calling.

CHORTLE CALLS

Another generalized vocalization of the Purple Martin was the chortle call (Fig. 2C and 2D). Frequency of this polysyllabic call was 1 to above 3 kHz. Texas chortle calls ranged from about 130 to 220 msec in duration, while Arizona calls lasted about 300 to 600 msec. The major difference between Texas and Arizona chortle calls was in duration. In Texas martins,

chortle calls were often given singly or in series of two or three, separated by intervals of 0.2 to 0.5 s. In Arizona, chortle calls were often strung together almost continually for up to 1 s or longer. Chortle calls were closely associated with *cher* calls and sometimes the two were joined.

Chortle calls generally occurred in a variety of contexts, much like *cher* calls, although chortles were not as frequent as *chers*. Chortles often seemed to indicate a slightly higher level of excitement, being given by males and fe-

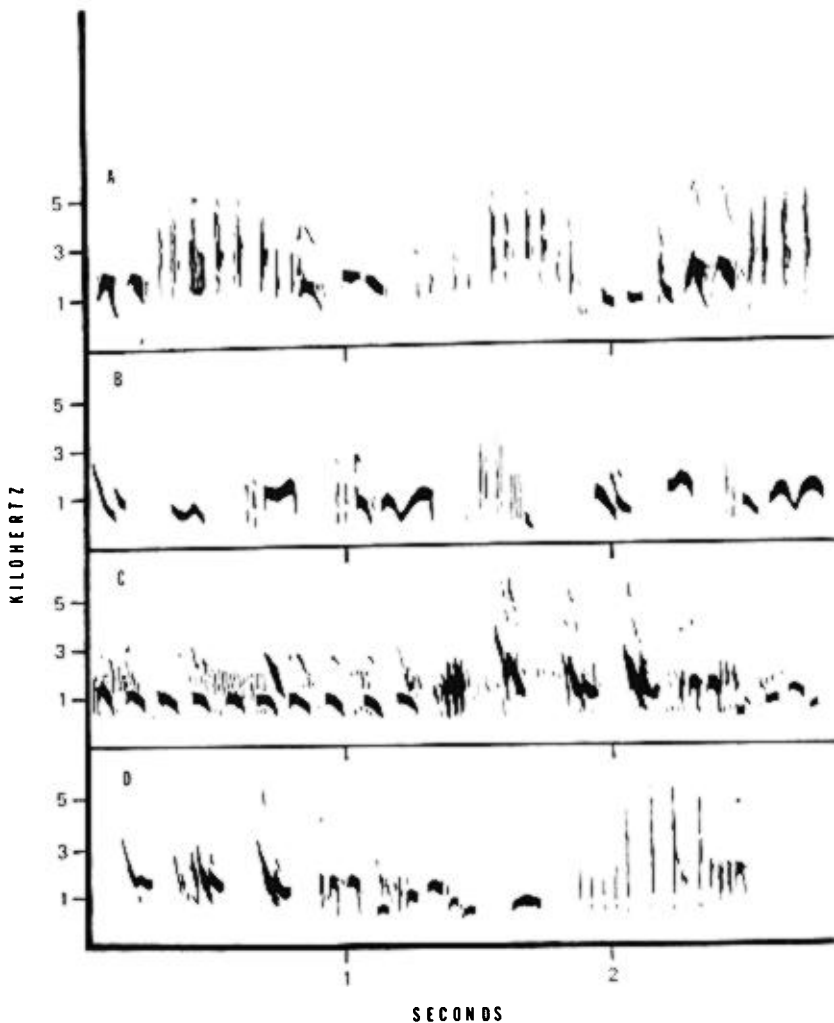


FIGURE 3. Sonograms of Purple Martin vocalizations: A, B, two Arizona croak songs from different individuals; C, D, two Texas croak songs from different individuals.

males immediately before singing croak and chortle songs, respectively (see below). These calls were usually given while a martin was sitting. Females seemed to utter chortle calls more often than males, but I have no comparative quantitative data. Chortle calls were given both during the day and during predawn hours in Texas martin colonies.

CROAK SONGS

Perhaps the most distinctive vocalization of the Purple Martin was the male's croak song (Fig. 3). The frequency range for Texas songs was (for most syllables) from 1 to 3 kHz. Some of these songs contained a series of gratings with a frequency range of 1 to 6 kHz. Most Texas croak songs lasted 1.5 to 3 s. In the songs where gratings were present, they occurred in the final 0.4 to 0.6 s of the song (Fig. 3D). Some Texas croak songs had no gratings (Fig. 3C). The remainder of the song in Texas birds

consisted of 8 to 12 distinct syllables, each about 40 to 80 msec in duration without pronounced harmonics; these syllables were not constituents of any other vocalizations. Texas birds invariably incorporated *cher* calls into the croak song, either as beginning or middle syllables (Fig. 3D and 3C, respectively). Chortle calls were also closely associated with croak songs in Texas birds.

Frequency range for Arizona croak songs was from 1 to 3 kHz with some harmonics up to 5.5 kHz. All these songs contained regularly repeating series of gratings of 1 to 5 kHz. Individual gratings of most songs were doubled, creating a slight echo effect for each grating. Arizona songs ranged from 2 to 6 s in duration. All contained at least two separate series of gratings, and most contained at least three series. Each series had a duration of 0.25 to 0.90 s, and thus it was possible for over half of some songs to be composed of gratings (Fig. 3A).

Even in the Arizona songs in which series of gratings were not so numerous, scattered individual gratings were interspersed with other syllables throughout the song (Fig. 3B). Between each series of gratings in Arizona croak songs were two to four syllables (some showing slight harmonics), each 80 to 210 msec in duration. On occasion, Arizona males gave single prolonged sequences of gratings up to 1 s in duration unaccompanied by any other syllables.

I heard croak songs given only by males in sexual and courtship contexts. In Texas they occurred mainly during the early and middle part of the nesting season while birds were arriving, forming pairs, and nest-building. In Arizona they lasted with declining frequency into incubation and feeding of young. Toward the end of the nesting season, males mainly gave subsong (see below) instead of full croak songs. Croak songs in general were used during courtship periods whenever males observed females near them. Unmated males engaging in the Claiming-Reclaiming Display (Johnston and Hardy 1962) in the presence of a female frequently uttered croak songs. Even after pairing, males continued to give croak songs to their mates. However, mated males gave croak songs to other females in the colony when they approached them at loafing sites and also (along with *weet* calls) when unmated females intruded into their territories. Croak songs were given when members of a pair rejoined after having been separated. Males gave croak songs when chasing their mates in Pair Chases (Brown 1978b), before and after copulations with their mates, and when attempting to forcibly copulate with other females (Brown 1978b). Male martins in Arizona, returning to relieve their incubating mates in the nest cavity, first perched on nearby limbs and sang croak songs, whereupon the females emerged. Texas male martins did not always sing when returning to relieve their mates. During the song, males often wing- and tail-flipped, opened the beak considerably, and exposed a patch of bare skin on the throat. Croak songs were given both in flight and at rest.

The croak song was the most prevalent vocalization given by male Purple Martins during predawn hours in Texas colonies. Many recordings were made, lasting up to 20 s, in which only croak songs were uttered continuously. During predawn hours, a male frequently gave up to ten croak songs within a 2-min period, yet during the day I never heard a male give more than four songs in any 2-min period. Nocturnal croak songs came from inside the nesting houses and also from martins that left their birdhouses and flew

nearby. Morning flights began about 05:00 when males left the houses, still in total darkness. They remained airborne nearby, singing repeatedly, until dawn when they returned to the houses. Females apparently did not leave the nesting houses at night. Croak songs inside the martin houses were often accompanied by loud "thumping" noises, which may have been caused by the thrashing of wings against the birdhouse walls during copulation.

Both adult and first-year male Purple Martins (which are strongly age dimorphic) gave croak songs. I detected no differences between songs of adults and first-year birds.

CHORTLE SONGS

Chortle songs (Fig. 4A and 4B), given only by females, were used in the same contexts in which croak songs were used by males. These vocalizations had a frequency range of 1 to 3 kHz with a few syllables approaching 4 kHz. Typically they lasted 1 to 2.5 s with none longer than 3 s. Chortle songs were composed of two major types of syllables: syllables closely resembling chortle calls and downslurred syllables containing harmonics. These chortle syllables and harmonic syllables were strung together in various combinations to create a distinct song. Texas songs generally contained more chortle syllables than downslurred syllables, while the reverse was true for Arizona songs.

Chortle songs were used by female Purple Martins in several situations, but usually in sexual or courtship contexts. They were most often given by females during pair formation. Females uttered chortle songs when they rejoined their mates after having been separated. This song, and the male's croak song, may function in maintaining the pair bond. Resident females also gave this song when non-resident females intruded into their territories, and the chortle song thus could function as a territory advertisement or threat. Although mostly confined to the early stages of the nesting cycle in Texas, in Arizona incubating females commonly gave this song when their mates arrived at the nest to relieve them. I did not hear the song in flight. Martins in Texas colonies often gave chortle songs in predawn hours. All chortle songs came from inside the birdhouses at that time.

SUBSONGS

Subsongs were recorded only from male Purple Martins near the end of the nesting season (Fig. 4C and 4D). They had basically the same acoustical and structural properties as croak songs, although shorter in duration (usually

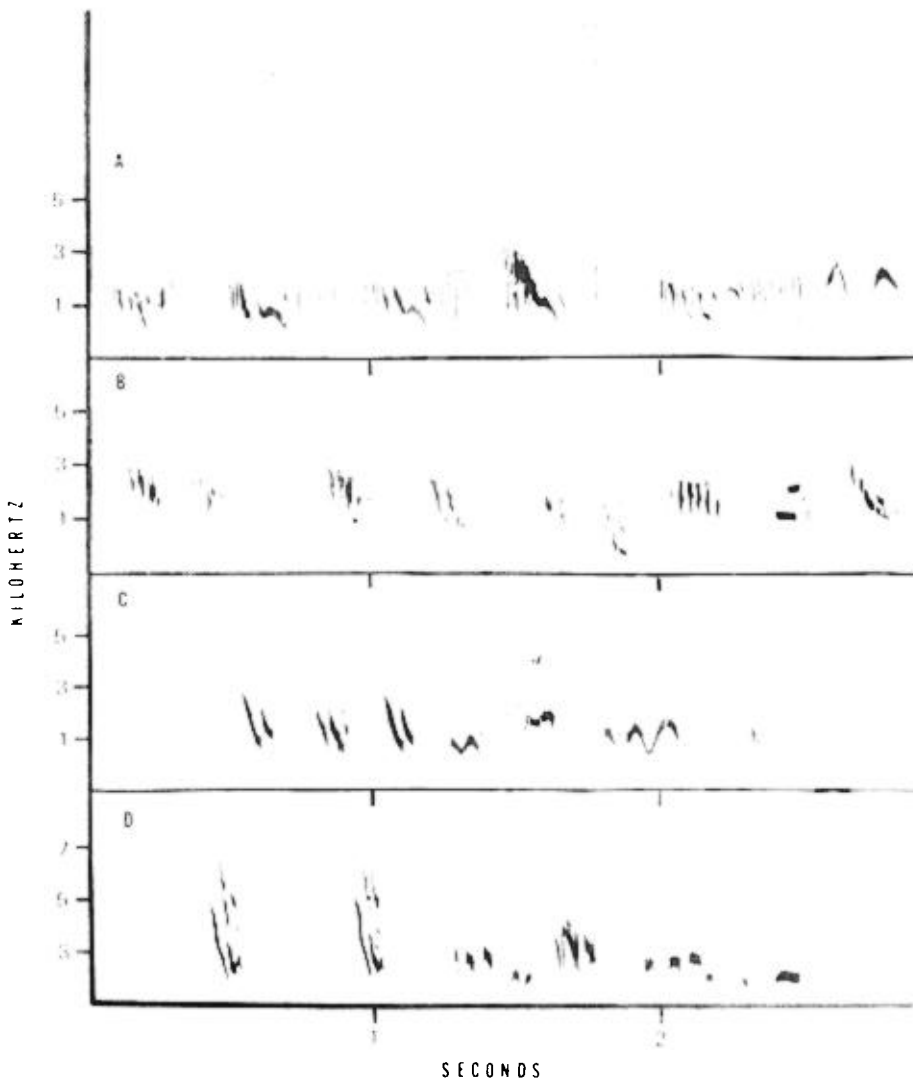


FIGURE 4. Sonograms of Purple Martin vocalizations: A, an Arizona chortle song; B, a Texas chortle song; C, an Arizona subsong; D, a Texas subsong.

not more than 2 s) and less intense. *Cher* calls were incorporated into the beginnings of subsongs of both Texas and Arizona martins. Subsongs of Texas birds did not include any gratings, and in Arizona subsongs intensity and number of gratings were less.

Subsongs were most frequent after birds began feeding young and during premigratory flocking, although they did occasionally occur throughout the nesting season. Adult and first-year males both gave subsongs, whereas I did not hear independent juveniles give them. Subsongs, unlike croak songs, were not restricted to sexual contexts and were given in a variety of situations. Most often, however, they were given when martins appeared to be at least moderately aroused, as when incoming birds approached a loafing site.

DISCUSSION

Purple Martins clearly possess as large a vocal repertoire as any swallow studied to date. In this study, I found martins had ten different types of calls, compared to three in the semi-colonial Violet-green Swallow (*Tachycineta thalassina*; Brown 1983), four in the highly colonial Cliff Swallow (Samuel 1971; Brown, in press), and eight to ten in the largely solitary Barn Swallow (*Hirundo rustica*; Samuel 1971, Brown, in press). These comparisons of repertoire size are valid because the same observer(s) studied each species and therefore the observed sizes are not biased by different investigator classifications. In the case of the Barn and Cliff swallows, Samuel (1971) and Brown (in press) agreed closely on repertoire

size. Thus, the (historically solitary) Purple Martin and Barn Swallow probably do have truly larger vocal repertoires than the more colonial Cliff and Violet-green swallows, in accord with Brown's (1983, in press) hypothesis. Briefly, this hypothesis states that colonial species have smaller repertoire sizes because the continual hubbub from many individuals "must often render vocal communication chancy" (Smith 1977:358). Solitary species have fewer acoustical constraints on the evolution of repertoire sizes, and thus have more vocalizations. It is likely that, until recently with the widespread installation of multi-room birdhouses, martins were usually solitary, nesting in dispersed fashion wherever abandoned woodpecker holes could be found.

I found no evidence that colonial martins in Texas had smaller repertoires than those nesting solitarily in Arizona. I found ten types of calls in Texas martins versus nine in Arizona martins, but the difference is trivial especially since I studied martins in Texas much longer. This finding suggests that vocal repertoire size is not evolutionarily plastic and has not responded to the recent shift toward colonial nesting by Purple Martins in eastern birdhouses.

However, vocalizations did differ structurally between Texas and Arizona populations of Purple Martins: *zweet* calls (Fig. 1G and 1H), chortle calls (Fig. 2C and 2D), croak songs (Fig. 3), and chortle songs (Fig. 4A and 4B). To my knowledge, no studies of geographical variation in vocalizations of other swallows have been published, so the data presented here are the first documentation of this phenomenon for the Hirundinidae. While geographical variation and song dialects have received much research attention in recent years (e.g., references in Thielcke 1969, Bitterbaum and Baptista 1979), their evolutionary significance is still not known. No hypotheses to explain them have attained complete acceptance.

The hypothesis of Nottebohm and Selander (1972) may nevertheless apply to Purple Martins. These workers proposed that dialects may serve to reduce gene flow between populations which experience different selective pressures, promoting assortative mating. In short, dialects might serve as "badges" to indicate to which habitat or region a population is adapted. Both habitat and climate differ between northern Texas and southeastern Arizona, so it seems possible that differences in vocalizations of Purple Martins might serve as indicators of adaptation to widely different physical environments. Since these populations may mix on the wintering grounds in Brazil (al-

though we have no information on wintering ranges of these respective populations), vocalizations may be all the more important in maintaining segregation.

The difference in vocalization structure between Purple Martins in Texas (undoubtedly the nominate race *P. s. subis*) and those in Arizona has special significance because the long-recognized southwestern race of the martin, *P. s. hesperia* Brewster, occurs in Arizona. According to Kimball (1921), Brandt (1951), and Phillips et al. (1964), *hesperia* is confined to the deserts of south central Arizona and nominate *subis* inhabits the Chiricahua Mountains. However, limited recording of vocalizations of martins nesting in saguaros near Tucson (Brown, unpubl. data) shows that vocalizations of the saguaro-nesting martins are identical to those of the birds inhabiting the Chiricahuas, and furthermore they are qualitatively identical (to my ear). Strictly on the basis of voice, I would consider the Tucson population and Chiricahua population to have similar subspecific affinities, although morphologically the populations differ (Brandt 1951, Phillips et al. 1964). The morphological differences between these populations are based largely on females. It is difficult to judge whether mountain and desert birds should be separated on the basis of differing female morphology, or lumped on the basis of similar vocalizations. The vocalizations of both mountain and desert martins differ markedly from those of eastern nominate *subis*, as documented here. Additional recordings of Purple Martin vocalizations from the mountains of New Mexico and Colorado (closest areas of contact with the Great Plains-nesting nominate *subis*) are needed, but a re-examination of subspecific designations of Arizona Purple Martins might be warranted.

ACKNOWLEDGMENTS

I thank Howard McCarley for advice and assistance throughout this project. The Austin College Biology Department provided equipment and use of facilities. The Southwestern Research Station of the American Museum of Natural History provided logistical support in Arizona. Walter Piper helped me find martins in the Chiricahuas. Mary Bomberger assisted with the figures, and my parents, Raymond and Kathryn Brown, provided financial support.

LITERATURE CITED

- ALLEN, R. W., AND M. M. NICE. 1952. A study of the breeding biology of the Purple Martin (*Progne subis*). *Am. Midl. Nat.* 47:606-665.
- BITTERBAUM, E., AND L. F. BAPTISTA. 1979. Geographical variation in songs of California House Finches (*Carpodacus mexicanus*). *Auk* 96:462-474.
- BRANDT, H. 1951. Arizona and its bird life. Bird Research Foundation, Cleveland, OH.

- BROWN, C. R. 1978a. Post-fledging behavior of Purple Martins. *Wilson Bull.* 90:376-385.
- BROWN, C. R. 1978b. Sexual chase in Purple Martins. *Auk* 95:588-590.
- BROWN, C. R. 1979. Territoriality in the Purple Martin. *Wilson Bull.* 91:583-591.
- BROWN, C. R. 1980. Sleeping behavior of Purple Martins. *Condor* 82:170-175.
- BROWN, C. R. 1983. Vocalizations and behavior of Violet-green Swallows in the Chiricahua Mountains, Arizona. *Wilson Bull.* 95:142-145.
- BROWN, C. R. In press. Vocalizations of Barn and Cliff swallows. *Southwest. Nat.*
- BROWN, C. R., AND E. J. BITTERBAUM. 1980. Implications of juvenile harassment in Purple Martins. *Wilson Bull.* 92:452-457.
- FINLAY, J. C. 1971. Breeding biology of Purple Martins at the northern limit of their range. *Wilson Bull.* 83:255-269.
- JOHNSTON, R. F., AND J. W. HARDY. 1962. Behavior of the Purple Martin. *Wilson Bull.* 74:243-262.
- KIMBALL, H. H. 1921. Notes from southern Arizona. *Condor* 23:57-58.
- NILES, D. M. 1972. Molt cycles of Purple Martins (*Progne subis*). *Condor* 74:61-71.
- NOTTEBOHM, F., AND R. K. SELANDER. 1972. Vocal dialects and gene frequencies in the Chingolo Sparrow (*Zonotrichia capensis*). *Condor* 74:137-143.
- PHILLIPS, A., J. MARSHALL, AND G. MONSON. 1964. The birds of Arizona. Univ. of Arizona Press, Tucson.
- SAMUEL, D. E. 1971. Vocal repertoires of sympatric Barn and Cliff swallows. *Auk* 88:839-855.
- SMITH, W. J. 1977. The behavior of communicating. Harvard Univ. Press, Cambridge, MA.
- THIELCKE, G. 1969. Geographic variation in bird vocalizations, p. 311-339. *In* R. A. Hinde [ed.], *Bird vocalizations*. Cambridge Univ. Press, New York.
- THORPE, W. H. 1961. *Bird song: the biology of vocal communication and expression in birds*. Cambridge Univ. Press, New York.

Department of Biology, Princeton University, Princeton, New Jersey 08544. Received 24 August 1983. Final acceptance 28 March 1984.

The Condor 86:442
© The Cooper Ornithological Society 1984

RECENT PUBLICATIONS

Aves silvestres do Rio Grande do Sul.—William Belton. 1982. Fundação Zoobotânica do Rio Grande do Sul, Porto Alegre, Brazil. 169 p. plus 105 color photographs by J. Dunning. Paper cover. \$12.00. This neat pocketbook will help the travelling ornithologist identify the most common species of birds one might see in the State of Rio Grande do Sul, Brazil, and in its neighboring countries of Uruguay and Argentina. Belton, a long-time resident of southern Brazil, realized the need for a simple, Brazilian bird guide; his book nicely fills that need. Of the 573 known species of birds from the region, he chose the 102 most common; Dunning's well-executed (and well-printed) color photos accompany Belton's short descriptive text. Most birds are shown perching; some, however, are shown singing or feeding. References are made in the text to another one hundred or so species. Some of the species described are familiar to North Americans either as summer residents here and winter visitors in Brazil (e.g., Lesser Yellowlegs) or as breeding birds widespread in both Americas (Burrowing Owl, Black Vulture, Common Snipe, Common Ground-Dove). Some are common in the neotropical Realm (e.g., Common Potoo, *Nyctibius griseus*; Squirrel Cuckoo, *Piaya cayana*; Rufous Hornero, *Furnarius rufus*; and Rufous-collared Sparrow, *Zonotrichia capensis*). Many,

however, are endemics, restricted to the wider area of Amazonia or only to southeastern Brazil. The book is written in Portuguese, yet is quite understandable for those individuals with a basic knowledge of Spanish.—M. D. F. Udvardy.

La avifauna en Villa María y sus alrededores.—Sergio A. Salvador. 1983. Escuela Normal "Victor Mercante," Instituto Secundario "Bernardino Rivadavia," Villa María, Córdoba, Argentina. 26 p. Paper. Price not given. Source: S. A. Salvador, Boulevard Sarmiento 698, 5900 Villa María, Córdoba, Argentina. Villa María is about 540 km WNW of Buenos Aires. The regional avifauna is transitional between that of the semiarid pampas and the more humid chaco. This pamphlet, in Spanish, is a list of the 209 bird species seen or collected there between 1973 and 1982. For each species, very brief notes give its status, habitat, and whether or not nesting has been confirmed. Supplementary lists and tables analyze the birds according to their seasonal occurrence. List of references. Useful information for those who are interested in the distribution of South American birds.