J. Field Ornithol., 61(4):380–387

VOCAL REPERTOIRE OF THE MEXICAN CHICKADEE I. CALLS

MILLICENT SIGLER FICKEN
Department of Biological Sciences
University of Wisconsin–Milwaukee
Milwaukee, Wisconsin 53201 USA

Abstract.—I describe acoustic structure and use of calls (excluding song and song-like vocalizations) of Mexican Chickadees (*Parus sclateri*). Calls are compared with those of other North American gray-backed chickadees. The general call repertoire of the Mexican Chickadee is similar to other chickadees however, the "chick-a-dee" call of the Mexican Chickadee is very different in acoustic structure from calls of other members of its species group. Other differences in acoustic structure may be due to the linkage, rather than independent evolution of certain calls.

REPERTORIO VOCAL DE *PARUS SCLATERI*
I. LLAMADAS

Sinopsis.—Describo la estructura acústica y uso de llamadas (excluyendo las canciones y vocalizaciones parecidas a cantos) de *Parus sclateri*. Las llamadas son comparadas con las producidas por otra aves de Norteamérica del mismo género. Encuentro que el repertorio en general del ave estudiada es similar a la de otros congéneres. Sin embargo, la llamada "chic-a-di" de la especie mexicana es diferente en estructura acústica a la llamada de otros miembros del grupo de especies. Otras diferencias en la estructura acústica podrían deberse a la unión, en vez de la evolución independiente, de ciertas llamadas.

The Mexican Chickadee (*Parus sclateri*) is poorly known compared to the other, well-studied gray-backed chickadees of North America. Dixon and Martin (1979) performed the first sonagraphic analysis of several vocalizations of this species, and noted marked differences from other chickadees. Here a more detailed sonagraphic analysis and description of use of calls are provided. Songs and song-like vocalizations are treated elsewhere (Ficken 1990b). I compare vocalizations of the Mexican Chickadee with other closely related chickadees for which sonagrams are available: Black-capped Chickadee, *P. atricapillus* (Ficken et al. 1978), Carolina Chickadee, *P. carolinensis* (Smith 1972), and Mountain Chickadee, *P. gambeli* (Dixon et al. 1970, Gaddis 1985).

STUDY AREA AND METHODS

The main study site was Rustler Park in the Chiricahua Mountains (Cochise Co.), Arizona, the site of Dixon and Martin's (1979) study. Three visits were made: 5 and 6 Oct. 1985, 15–17 and 19 May 1986, and 5–10 Oct. 1986. Recording began shortly after dawn and continued until the birds showed a marked decrease in vocalizing around noon. In October, I followed flocks, but attempted to record the vocalizations of a single focal bird before moving on to another in order to obtain some samples of known individuals. Three to five different flocks were studied each fall (they were sufficiently distant from each other that it was unlikely that individuals moved between them). In May recording was concen-

trated near the nest of one pair, but the territories of at least five other pairs were visited. Apart from the focal pair, however, vocalizations were infrequent except during territorial boundary encounters.

I used a Sony Walkman Professional cassette tape recorder, with an Electrovoice Soundspot microphone in 1985, and a Nakamichi CM-100 cardioid microphone in 1986. In addition to recording vocalizations, as much data as possible were included on their contexts. Vocalizations were analyzed with a Kay 7800 Digital Sona-Graph (150 Hz filter band width).

RESULTS

Only one nest was observed (young were present on the day it was found—15 May). As this species is sexually monomorphic and birds were unmarked, the role of the sexes in care of the young could not be determined unequivocally.

During the non-breeding season, mixed species flocks consisted of 30–100 individuals including four to six chickadees and numerous other species. The flocks ranged over a rather large area. The chickadees called frequently (mainly "Chick-a-dee" calls); other species except for Pygmy Nuthatches (*Sitta pygmaea*) were much less vocal. In many cases two chickadees foraged within 1 to 2 m of each other, with a third much more distant (>10 m). Other chickadees were at least 20 m farther away. Very little chasing or supplanting was observed, much less than in fall flocks of Black-capped Chickadees (pers. obs.).

I use the call terminology of Ficken et al. (1978) for the Black-capped Chickadee, which is based largely on that of Smith (1972) for the very similar repertoire of the Carolina Chickadee. The use of the same terms does not imply homology necessarily. The entire vocal repertoire of the Mexican Chickadee may not have been sampled, particularly some rare calls that may occur only in specific contexts. It is likely, however, that the major call categories were recorded.

"Chick-a-dee" calls.—The "Chick-a-dee" call sounds quite different from those of other gray-backed chickadees. A detailed analysis of this call complex will be presented elsewhere (Ficken and Hailman, in prep.), but a brief description is provided for comparisons with other calls in the species' repertoire. Three note-types in this complex call are relatively common (A, C and D in Fig. 1a and b). In over 1000 calls only one or two examples were found of a note-type that is similar to the B note-type of the Black-capped Chickadee (Fig. 1b). The same letters are used for designation of note types as for the Black-capped Chickadee (Ficken et al. 1978), but at this preliminary stage of analysis, homology is not implied.

The A note-types are quite variable in pitch and duration. They have a zig-zag pattern on a sonagram, showing rapid frequency modulation which gives them a buzzy quality very different from calls of other chickadees. The B and C are more similar to those of the Black-capped Chickadee. The D note-type shows some similarities with comparable notes of

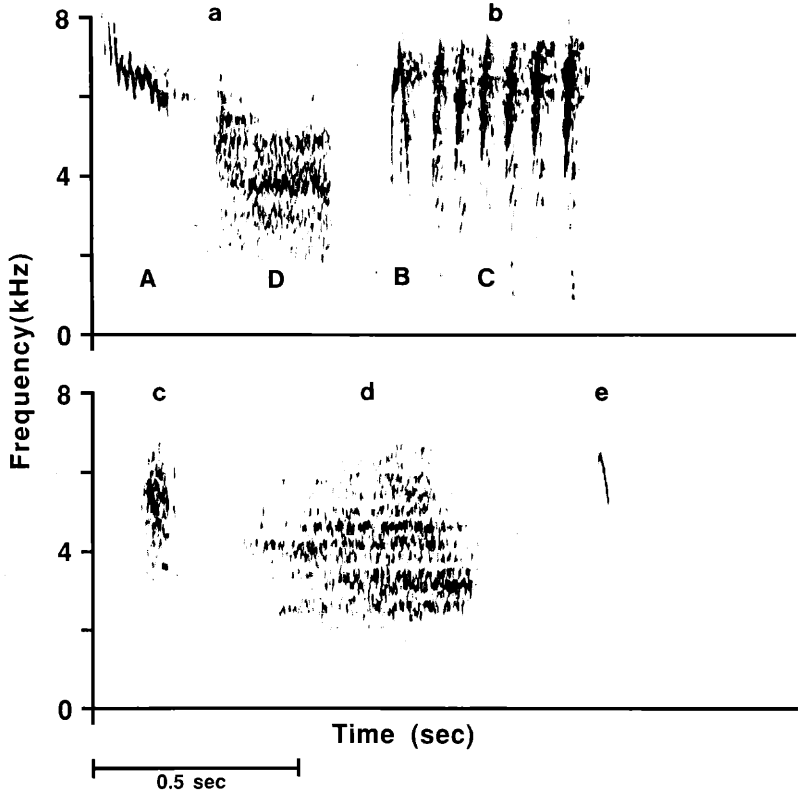

FIGURE 1. a. call in "Chick-a-dee" complex showing A and D note-types. b. call in "Chick-a-dee" complex showing B and C note-types. c. "Hiss" (a very short one). d. "Hiss" (a long one, showing a slight but interrupted banding pattern). e. "Tseet."

congeners, but has a much reduced banded pattern, and these notes sound much harsher and noisier.

As is the case with many other chickadees, the "Chick-a-dee" call is complex with many variations. Note-types occur in different combinations and the number of repetitions of note-types is also variable. This combinatorial system has been analyzed in detail in the Black-capped Chickadee (Hailman et al. 1985).

"*Hiss.*"—The "Hiss" is one of the most unusual calls of this chickadee, both in acoustic structure and usage. The call is highly variable (two extreme examples are in Fig. 1c and d). Coefficients of variation were very large for both lowest frequency and duration (Table 1). For an indication of variability, I compare the acoustically rather similar D note to "Hisses" from the same bird. Coefficients of variation were much less for the lowest frequency and duration of the D note than for the "Hiss."

The "Hiss" sounds like a sudden exhalation of air. Well-defined fre-

TABLE 1. Characteristics of "Hisses" compared with the D note from the same individual.

Note type		Highest frequency (kHz)	Lowest frequency (kHz)	Duration (s)
Hiss	$\bar{x}$	7.90	2.79	0.10
	n	6	9	9
	C.V.	5.4	49.1	70
D note	$\bar{x}$	6.79	3.38	0.24
	n	11	12	12
	C.V.	8.8	8.8	30.2

quency bands are infrequent and when they occur they are broken, unlike the more regular banding patterns typical of D notes of other gray-backed chickadees. "Hisses" are similar to the D note-type in this species, but differ in their greater variability and in usually being uttered singly and never in conjunction with other note-types of the "Chick-a-dee" complex. Occasionally two or more "Hisses" may be given, but then they usually exhibit variable inter-call intervals rather than the more regular intervals between D notes in a series.

"Hisses" are given in a wide variety of situations, always when a bird is perched. They are not confined to social contexts, as they are sometimes given by lone birds that are temporarily separated from other group members during the fall. They are more frequent when individuals are in close proximity in flocks. Hisses often occurred during bouts of "Gargles" in territorial encounters (Ficken 1990b), the apparent recipient of the "Gargles" gives the "Hisses." Many were recorded near the nest hole, just before a bird entered the cavity. Because of the varied usage, it is difficult to ascribe a message to this call. "Hisses" often occurred, however, in situations when there was some hesitancy to locomote, or where the caller may have been slightly fearful.

"Hisses" are widespread in parids. Thielcke (1968) reported them in 13 species. However, in all other parids for which the call is reported, the usage is very different from that in the Mexican Chickadee. In other species, "Hisses" are usually given within the nest cavity as the parent or nestlings sway back and forth (Thielcke 1968). The acoustic quality of the call and the nature of the associated movement gave rise to the hypothesis that it is Batesian mimicry of a snake (Pickens 1928, Sibley 1955).

"*Tseets.*"—These are very short, low amplitude notes (Fig. 1e), that are uncommon ($n = 6$, but others may not have been detected). The sample size is small, and usage is uncertain, but they seem associated with agonistic situations in which the caller may be somewhat fearful, as seems to be the case in the very similar call of the Black-capped Chickadee (Ficken et al. 1978).

"*Twitter.*"—The calls consist of a variable number of very rapidly uttered transients that cover a wide frequency range and appear as nearly

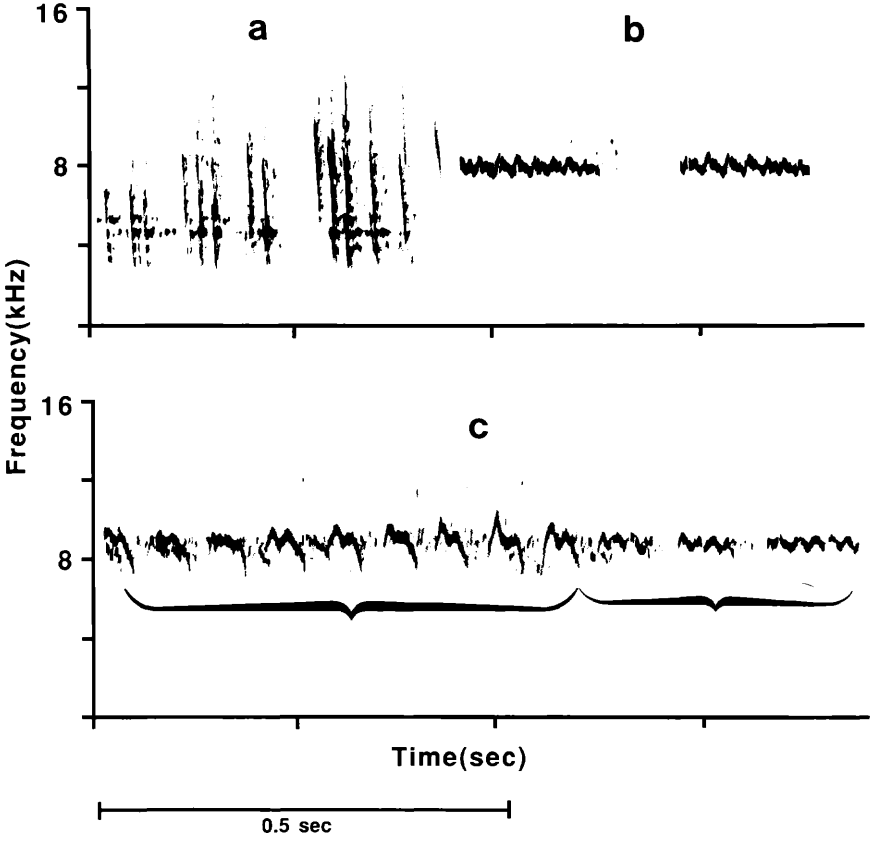

FIGURE 2. a. "Twitter." b. "High Zees." c. "Variable Sees"—brackets indicate the two members of the pair; the second bird was calling during the calls of the first bird but its calls were masked until the first bird ceased calling.

vertical lines on sonagrams (Fig. 2a). Only five were recorded. Twitters are low amplitude calls used at close range between members of a pair. Twice Twitters occurred as a bird entered the nest hole while another was still in it, an unusual circumstance as one usually exited when another approached. These cases of a sudden confrontation are similar to the usage of the very similar call in the Black-capped Chickadee (Ficken et al. 1978).

"*High Zees.*"—This type of vocalization, widespread in passerines, is the one referred to as an aerial predator call (Marler 1955), although its usage is not restricted to aerial predators in the Black-capped Chickadee (Ficken and Witkin 1977). In general, the acoustic properties of this call are similar to those reported in other passerines: high pitched and covering a narrow frequency range (e.g., Marler 1955). "High Zees" of Mexican Chickadees are higher pitched than the corresponding calls of the Black-

capped Chickadee (Ficken and Witkin 1977) and Carolina Chickadee (Smith 1972). Calls of these other chickadees show little frequency modulation within a note, while those of Mexican Chickadees have a zig-zag appearance in sonagrams, indicating small, but consistent intra-note frequency variations (Fig. 2b). In Mexican Chickadees "High Zees" are simply higher pitched versions of the A note-type of the "Chick-a-dee" complex, as is the case in the Black-capped Chickadee (pers. obs.) and the Carolina Chickadee (Smith 1972). Thus the different structure of the "High Zees" of the Mexican Chickadee is a reflection of the different structure of its A note. Calls given in high risk situations were significantly higher pitched than those occurring in low risk situations (Ficken 1990a).

"*Variable Sees.*"—This is the highest pitched vocalization of Mexican Chickadees (mean highest frequency = 9.84 kHz, S.D. = ±0.65; duration 0.062 s ± 0.024, n = 19 from at least 4 individuals) (Fig. 2c). "Variable Sees" are quite similar to "High Zees," often having rapid intra-note frequency modulation, and a narrow frequency range. However, they are of shorter duration and average about 1 kHz higher.

Similar calls occur in Carolina Chickadees (Smith 1972), Black-capped Chickadees (Ficken et al. 1978) and Mountain Chickadees (Dixon et al. 1970). In the Black-capped Chickadee, the same frequency relationship holds between "High Zees" and "Variable Sees" (with about a 1 kHz difference between the two calls), but both calls are about 1 kHz higher in the Mexican Chickadee.

"Variable Sees" were restricted to pair interactions, and were more common in spring than fall. In May a bird often gave them near the nest hole when returning with food for the young (n = 20); it typically perched within 1 m of the nest and began giving either "Gargles" (Ficken 1990b) or "Variable Sees," the latter often accompanied by wing quivering. Another individual usually left the nest cavity and sometimes the two remained perched near each other, both giving "Variable Sees" accompanied by wing quivering. Some calling interactions between the pair lasted as long as 6 s. When both birds called, overlapping of calls sometimes occurred, or a duet in which one bird's calls directly followed the other's. In such cases, the calls of the two birds were very distinctive (Fig. 2c).

DISCUSSION

The two highest pitched calls of this chickadee, "Variable Sees" and "High Zees," are both used in contexts in which the receiver is within a few meters of the caller. Both have frequency characteristics that lead to rapid attenuation (Wiley and Richards 1982). Although the general messages of the two calls are very different (one a predator alert, the other associated with pair interactions), the similarities in acoustic properties may be due to selection favoring design features for a short transmission distance. Perhaps in addition, there are limitations on the acoustic structure of very high pitched vocalizations, as at least in chickadees, they

often seem much simpler in general acoustic structure than other calls in the species' repertoires, and consist of long strings of similar note-types.

While each call has been discussed separately, an interlinked system of calls is apparent, rather than each call evolving as an independent entity. For example, similarities are strong between the A note of the "Chick-a-dee" call, "High Zees" and "Variable Sees." The "Hiss" shows some similarities to the D in the "Chick-a-dee" call. It is probably not coincidental that the Mexican Chickadee, the parid species with the broadest usage of the "Hiss," is also the only one in which the D seems to have secondarily reduced its banding pattern, and resembles the "Hiss," indicating a linkage of the evolution of the two calls.

The vocal repertoires of the gray-backed chickadees are remarkably similar. All calls of the Mexican Chickadee have apparent homologs (based on phonological similarity) in the Black-capped and Carolina Chickadees, the best studied North American species. Two additional calls of adults of the former species were not noted in the Mexican Chickadee. One ("Snarl"), occurs only in fights (Ficken et al. 1978), and as this type of aggression was so rare in Mexican Chickadees, its absence in my recordings is not unexpected. The second call, "Broken Dees," is common in Black-capped (Ficken et al. 1978) and Carolina Chickadees (Smith 1972), and is given by females during a part of the breeding season that was not adequately sampled in my study.

Based on genetic analysis, the Mexican Chickadee probably is most closely related to the Mountain Chickadee, and more distantly to the Black-capped and Carolina Chickadees (Gill et al. 1989). My analysis indicates that Mexican Chickadees are more different in the acoustic structure of "Chick-a-dee" calls from the other three species than are those species from each other (for comparison, see sonagrams in Ficken et al. 1978, Gaddis 1985, Smith 1972). Further studies are needed before extensive behavioral comparisons can be made.

ACKNOWLEDGMENTS

I thank Robert Ficken for assistance in the field and in preparing sonagrams. Keith Dixon, Jack Hailman, Stephen Nowicki, and David Spector made many helpful comments on an earlier version of the manuscript. I am grateful for the use of the facilities of the Southwestern Research Station of the American Museum of Natural History.

LITERATURE CITED

DIXON, K. L., AND D. J. MARTIN. 1979. Notes on the vocalizations of the Mexican Chickadee. Condor 81:421–423.

———, R. A. STEFANSKI, AND F. N. FOLKS. 1970. Acoustic signals in the mating of Mountain and Black-capped Chickadees. Auk 87:322–328.

FICKEN, M. S. 1990a. Acoustic characteristics of alarm calls associated with predation risk in chickadees. Anim. Behav. 39:400–401.

———. 1990b. Vocal repertoire of the Mexican Chickadee. II. Song and song-like vocalizations. J. Field Ornithol. 61:388–395.

———, R. W. FICKEN, AND S. R. WITKIN. 1978. The vocal repertoire of the Black-capped Chickadee. Auk 95:34–48.

———, AND S. R. WITKIN. 1977. Responses of Black-capped Chickadee flocks to predators. Auk 94:156–157.

GADDIS, P. 1985. Structure and variability in the vocal repertoire of the Mountain Chickadee. Wilson Bull. 97:30–46.

GILL, F. B., D. H. FUNK, AND B. SILVERIN. 1989. Protein relationships among titmice (*Parus*). Wilson Bull. 101:182–197.

HAILMAN, J. P., M. S. FICKEN, AND R. W. FICKEN. 1985. The "chick-a-dee" calls of *Parus atricapillus*: a recombinant system of animal communication compared with written English. Semiotica 56:191–224.

MARLER, P. 1955. Characteristics of some animal calls. Nature 176:6–8.

PICKENS, A. L. 1928. Auditory protective mimicry of the chickadee. Auk 45:302–304.

SIBLEY, C. H. 1955. Behavioral mimicry in the titmice (Paridae) and certain other birds. Wilson Bull. 67:128–132.

SMITH, S. T. 1972. Communication and other social behavior in *Parus carolinensis*. Publ. Nuttall Ornithological Club No. 11.

THIELCKE, G. 1968. Gemeinsames der Gattung *Parus*. Ein bioakusticher Beitrag zur Systematik. Vogelwelt 1:147–164.

WILEY, R. H., AND D. G. RICHARDS. 1982. Adaptations for acoustic communication in birds: sound transmission and signal detection. Pp. 131–181 *in* D. Kroodsma and E. Miller, eds. Acoustic communication in birds. Vol. 1. Academic Press, New York.

Received 31 Jul. 1989; accepted 11 Jan. 1990.