VOCALIZATIONS OF THE BOREAL CHICKADEE

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VOCALIZATIONS are a conspicuous and complex aspect of the behavior of chickadees (*Parus*). While territorial advertizing song tends to be the most complex and widely recognized vocalization of most passerines, the best known vocalization of all the chickadees is the familiar "chickadee-dee," not an advertizing song but a locative note. The Boreal Chickadee (*Parus hudsonicus*) is of particular interest because of conflicting reports in the literature of the occurrence of a musical song (see Bent 1946). The present study of the vocalizations of the Boreal Chickadee was carried out in Algonquin Provincial Park, Nipissing District, Ontario.

METHODS

The Boreal Chickadee is known primarily as a bird of black spruce-balsam fir (*Picea mariana-Abies balsamea*) associations and these are the major arboreal components of its habitat in Algonquin Park, but with considerable interspersion of white spruce (*Picea glauca*), trembling aspen (*Populus tremuloides*), and white birch (*Betula papyrifera*). Black-capped Chickadees (*Parus atricapillus*) were present on the study area, but no interaction between the two species was noted.

Recordings of vocalizations were made with a Uher 4000-L tape recorder and a Uher M 537 microphone mounted in a Dan Gibson professional model parabola. All recordings were made at 7½ inches per sec and analyzed with the aid of a Kay Electric Company Sona-Graph model 6061B. The band filter widths of this model are 45 hz for the narrow band and 300 hz for the wide band. Both wide and narrow band spectrograms, some made at ½ or ¼ speed, were used in analysis of the structure of calls. On all spectrograms all burns clearly separated from other burns are designated syllables. On spectrograms of the musical call segments are groups of syllables, the entirety of which is repeated in the same sequence.

Observations of behavior associated with vocalizations were made primarily in the spring and summer of 1971 and 1972 (27 April to 30 July 1971; 12 April to 29 July 1972), but a few observations were made in the intervening winter.

RESULTS

"Chickadee" call and variations.—This call is given by both sexes throughout the year. It is a fairly complex call (Fig. 1A) consisting of a variably structured "chicka" and a fairly constant "dee." The "chicka" part of the call usually appears on spectrograms as a series of one to four upward pointing chevrons ranging in shape from wide and quite flat-topped to narrow and pointed with extended tails on the leading and/or trailing edge. "Chit" calls and "seep" calls (see below) are also frequently incorporated into or form the whole of the "chicka" part of the call. The physical structure of the "dee" part of the call is difficult

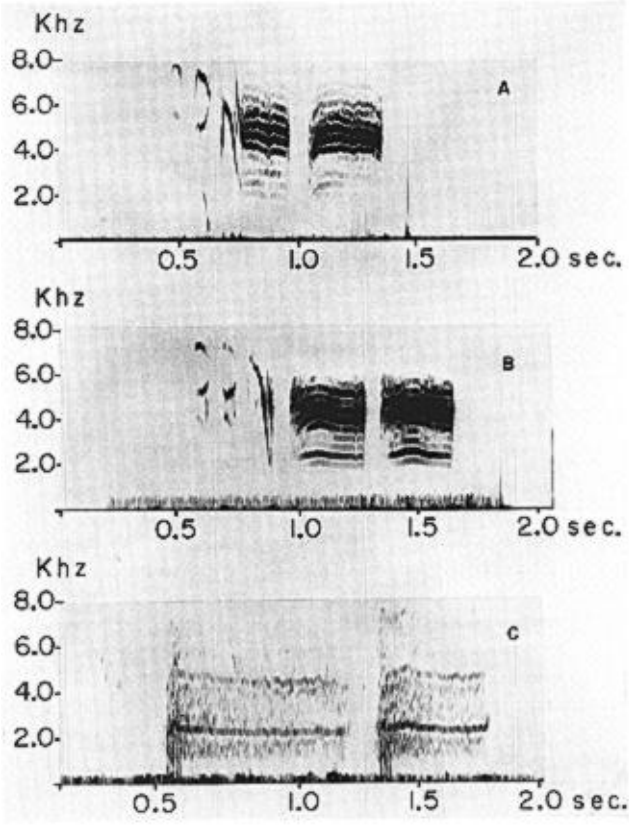

Fig. 1. A, "chickadee" call; B, separated "chickadee" call; C, hiss.

to determine. The series of bands appears to be harmonics, but the apparent precise harmonic relationship is not exact across all bands. Evidence of this is seen on Fig. 1A at the beginning of the first "dee." The bands at 3.0 and 4.0 Khz are clearly changing frequency in opposite directions at the onset. This is probably the result of the simultaneous emission of two fundamental frequencies each having its own series of overtones.

The "chickadee" call may be heard any time that a bird is perched, but was heard only twice from a bird in flight. This call has several variations that grade into one another, but at least two can sometimes be distinguished by ear from the general call note of an undisturbed bird. One of these variations is the separated "chickadee" call. When this type of call is given at full intensity, the emphasis is on the "dee" portion of the call and the entire call has a singsong rhythm that is

probably the result of the complete separation of the "chicka" and "dee" portions of the call (Fig. 1B). Another variation that is regularly distinguishable is the partial "chickadee" call. This is an abbreviated "chickadee" call consisting of, at most, two syllables in the "chicka" portion and a "dee" about half as long as the shortest "dee" in a full "chickadee" call.

The general call note is a locating note given by members of a flock or pair when separated. In the latter case, it may be given by birds that have wandered apart while foraging, and also by a male calling a female away from a hole she is excavating. This usually occurs early in the spring. Later in the season the male generally stays near the hole or helps the female excavate. In the event that he does wander off, he often gives "chickadee" calls; but although the female frequently replies with the same note, she rarely follows him.

The general call note "chickadee" and the partial "chickadee" are given by the male arriving at the nest while the female is incubating or brooding. In this instance the calls are given very quietly and the female responds by coming at least to the entrance of the hole, if not by flying out. Occasionally she does not respond and the male goes into the nest, but not without considerable hesitation and repeated "chickadee," partial "chickadee," or "seep" calls. On 2 of 171 occasions the male flew off when the female did not emerge.

A female leaving the nest spontaneously often gives the "chickadee" call. If she contacts the male she ceases to call. "Chickadee" calls may also be given by either sex when the male calls the female, but at all seven nests observed, "chickadee" calls were heard more frequently after a spontaneously terminated than after a male terminated attentive period ($P < 0.05$ sign test, two-tailed).

The use of the "chickadee" call as a distant contact note has also been reported in other *Parus* species. Odum (1942) noted that whenever a flock or pair of Black-capped Chickadees became scattered, an outburst of "chickadeeing" would reassemble it. Brewer (1961) states that this call also has a locating function in the Carolina Chickadee (*P. carolinensis*). The use of a contact call to announce the male's arrival at the nest contrasts with the use of a soft or modified version of the territorial advertising song in intrapair communication at the nest in many species. No calls that the Boreal Chickadee uses in territorial defense are used in this context.

The other major group of "chickadee" calls, the separated "chickadee" calls, seems to correspond to the scold call of the Black-capped Chickadee (Odum 1942) and are used in contexts involving other species. It was heard from birds that had just been supplanted from a potential nest

site by another species and from birds whose nest and/or young were being disturbed or could have been disturbed by a potential predator. The use of this call in scolding predators near the nest resembles mobbing behavior of other passerine species in the presence of hawks and owls. The function of such behavior in this species may be to distract the predator so that it does not notice the nest hole, a hypothesis supported by the parents' tendency to increase their scolding as the young grow old enough to be heard outside the nest.

Although the structural complexity of the "chickadee" call suggests the possibility of its use in individual recognition, limited evidence suggests that it is not so used. Twice when the "chickadee" calls of a female were played in the territory of her mate, the male responded with musical and trilled calls (see below) as he would to an intruding male. This is not entirely surprising when the function of the call is considered. As a location call it is primarily important during the 9 months between breeding seasons when individual identification at a distance may not be very important. Black-capped Chickadees (Odum 1942, Hamerstrom 1942, Hartzler 1970), Carolina Chickadees (Dixon 1963), and Mountain Chickadees (*P. gambeli*) (Dixon 1965) all recognize their conspecifics individually and form dominance hierarchies within the flock. Boreal Chickadees probably do likewise, but as the birds do apparently recognize each other all the time and they do not call constantly, the clues seem to be visual rather than auditory.

Musical and trilled calls.—These two calls are undoubtedly those referred to by Townsend and Allen (1907) and Allen (1910). These authors referred to the calls as musical "songs" but, as will be discussed, neither one can be considered a true territorial advertising song. The calls are discussed together as they are very similar in context and frequency of occurrence. Both are aggressive calls given only by males and may be uttered in tandem, i.e. a musical call following a trilled call with no longer an interval than occurs between the syllables of a single call. Further study is needed to determine what precise differences exist in these calls' contexts and functions.

The musical call (Fig. 2A) consists of repeated segments in each of which the syllables are identical or almost so. The number of segments in recorded calls varied from two to eight, the mode being four. The trilled call (Figs. 2C and 2D) always consists of two distinct parts—a fairly musical series of introductory notes followed by a series of staccato notes. The introductory segment has five to eight syllables that are generally different from the syllables of the musical call although some birds have a slight overlap. The second part of the call consists of a variable number of short notes with two frequency direction changes—

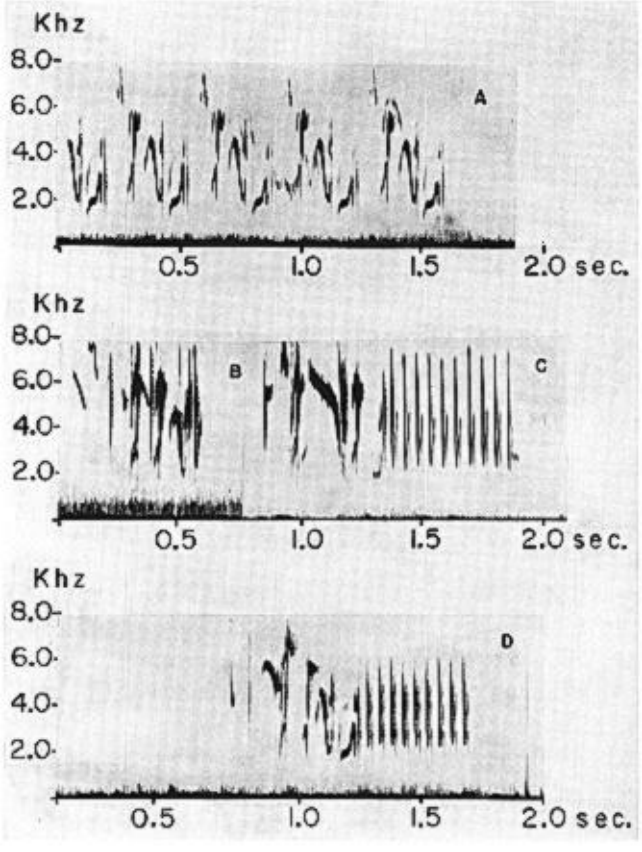

Fig. 2. A, musical call; B, rapid musical call; C, trilled call; D, trilled call (illustrated twice to show variation in the introductory syllables).

down-up-down. The initial downsweep encompasses a range of 6 Khz while the terminal up-down covers only 2 Khz.

The frequency of occurrence of musical and trilled calls increases as spring approaches and reaches a peak immediately before flock disintegration. The calls are given during chasing and supplanting attacks within the flock, but are also given while no actual conflict is occurring, perhaps as an expression of the general aggressiveness of males in early spring. I have seen the Black-capped Chickadee behave similarly in spring, giving an aggressive call while not actually supplanting or chasing another bird.

Once a pair has separated from the flock, the calls are given rarely except when other Boreal Chickadees are encountered. One or both were

heard in 19 of 20 such encounters ($P < 0.001$, χ^2), and it is apparently through a series of such encounters that territorial boundaries are established.

Territories are well-established by the beginning of nesting and these calls are rarely heard again until after the young fledge, when their frequency increases markedly. After the first postfledging week when both parents feed the young frequently, the rate of feeding decreases and the male becomes more aggressive toward the young. In 22 of 24 chasing or supplanting attacks by males on juveniles, the males gave one or the other of the musical and trilled calls ($P < 0.001$, χ^2). In three cases an adult male gave one of the two when a juvenile tried to supplant him. In all three cases the juvenile was unsuccessful.

The male also gave the musical call during 3 of 16 copulation sequences observed.

Juveniles give both of these calls within 3 weeks after leaving the nest. Although they are initially somewhat warbled and unclear, they are easily recognizable and by 3 to 4 weeks after fledging are indistinguishable from adult calls.

Neither of these calls seems to be analogous to other passerine songs. Although both calls are most common in spring, their frequency decreases markedly as soon as the birds begin to establish territories and neither is used during the inconspicuous patrolling behavior of this species, unless a conspecific is encountered. Nor are they used to attract a mate to the territory as pair formation occurs before flock disintegration.

The "phoebe" whistle of the Black-capped Chickadee, while serving in territorial announcement, is not indicative of aggressive tendencies on the part of the caller. Rather it has a beckoning function (Dixon and Stefanski 1970). As such the male uses it as he approaches the nest when the female is either incubating or brooding. Neither the musical nor trilled call was ever heard in this context, nor are they used to announce territory, but only to defend it (see McLaren (1975) for a further discussion of territorial defense). Dixon and Stefanski (1970) imply that both sexes of the Black-capped Chickadee give the fighting call, used once contact has been established in territorial encounters. Smith's (1972) "click-rasp" of the Carolina Chickadee is also given by both sexes in territorial disputes. The musical and trilled calls were not heard from female Boreal Chickadees.

Rapid musical call.—This call is closely related to the musical and trilled calls, and again it was heard only from males. In the field it gives the impression of a time-compressed musical call, but spectrograms (Fig. 2B) show the syllables to be a mixture of those in musical calls

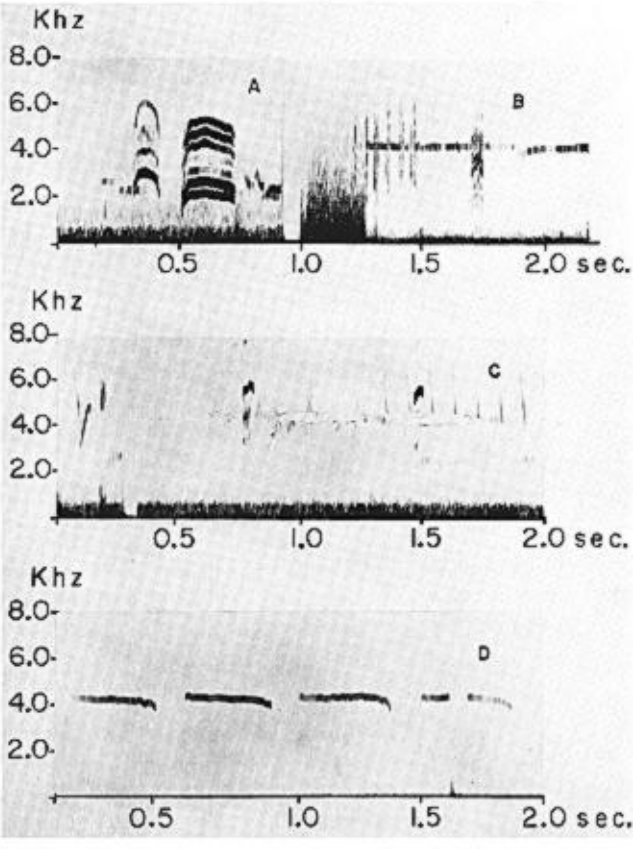

Fig. 3. A, female begging call; B, stutter call; C, male solicitation call; D, female solicitation call.

and those in the first part of trilled calls. The syllables are closer together than those of either musical or trilled calls.

This call is heard quite frequently in early spring before flock disintegration, along with musical and trilled calls, but it was not used in any chases or supplants. It was also given by the male while mounted in 4 of the 16 copulation sequences seen.

Stutter call.—This call was heard only infrequently but was given by both male and female. Fig. 3B shows an example of one of these calls. (The horizontal bar across this figure is the song of a White-throated Sparrow (*Zonotrichia albicollis*) in the background.) The physical structure of the call is quite simple. Each separate sound audible to the human ear is in reality a double unit consisting of two syllables 0.02 sec apart. Both drop in frequency from 7.5 to 2.5 Khz within 0.01 sec.

The stutter call is typical of close-quarters aggressive situations and, exclusive of its use during copulation (see below), was heard in no other context. The call was heard most often from an adult leaving the nest hole after feeding the young and finding the entrance blocked by its mate. As soon as the call was given the bird (either sex) entering backed out and the other exited. The call was also heard three times during supplanting attacks. On all three occasions the attack seemed to be concerned with food, the supplanter taking over the perch on, for example, a bunch of cones. Finally, this call was also heard, apparently from the male, in 3 of the 16 copulations observed. The call was given immediately prior to dismounting. The use of this call and also the musical and rapid musical calls during coition suggest that aggression is an important component of copulation in this species (McLaren 1975).

Solicitation calls.—Both male and female Boreal Chickadees give calls soliciting copulation (Figs. 3C and 3D). These figures are not directly comparable as the female call was analyzed at half speed, which doubled the call length and halved its frequency.

Solicitation calls, whether leading to copulation or not, are most common between the beginning of cavity excavating behavior and egg-laying. Solicitation and occasionally copulation occur again after the young fledge, but no eggs were found after these later copulations.

A bout of solicitation calls may be initiated by either sex. The male was not heard to give solicitation calls after initiation of the bout by the female, while the female did give solicitation calls after initiation by the male. Dixon et al. (1970) noted that either sex may initiate solicitation in the Black-capped Chickadee, while the male initiated the bout in the Mountain Chickadee.

Begging calls.—Begging calls are given by females during the prenesting and incubation period and by juveniles. Juvenile calls are not audible outside the nest before the 15th day after hatching, although they may be given somewhat earlier.

The initiation of begging behavior in the female Boreal Chickadee is more or less coincident with the beginning of cavity excavating. From this time until after the eggs hatch it is rare to see a female and male together without the female begging. The function of begging in the adult female is discussed elsewhere (McLaren 1975).

Although Odum (1942) mentions a "high pitched *eeee*" from newly hatched and very young Black-capped Chickadees, the call shown in Fig. 4A, typical of older nestlings and newly fledged young, was the first call heard from Boreal Chickadee chicks. Nestlings may give soft calls periodically when neither parent is present, but the calls become louder and more young call when an adult enters the nest or is visible to

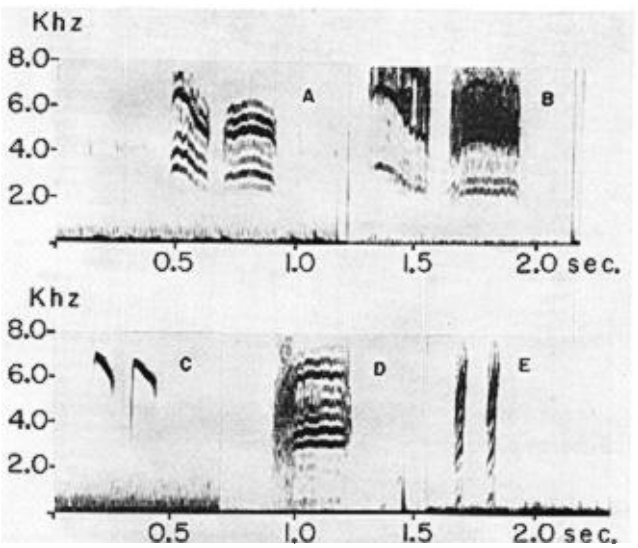

Fig. 4. A, juvenile begging call; B, older juvenile begging call; C, "seep" call; D, squeal; E, "chit" call.

the young through the entrance. On several occasions this sudden intensification of begging seemed to encourage the male, who was hesitating outside the hole, to enter immediately. No effect was apparent on the female, as she seldom hesitated before going into the nest.

After fledging, vigorous begging calls are accompanied by wing fluttering. The same pattern of calling is still apparent. One or more young call occasionally, and these become louder and more young call when an adult approaches. In this case the intensification of calling seems to be a result of social facilitation, as the fledgling being approached begs more loudly first, followed by the others that may be spread out in the nearby trees.

A change in the structure and sound of the juvenile begging call occurs on about the 5th day after fledging (Fig. 4B). These later calls are distinctly louder and their development accompanies the development of facile flight. The wing fluttering and pattern of calling remain the same as before, and for a week or more both types of calls may be heard. After this only the latter call is heard and begging generally decreases in frequency and intensity.

Squeal.—The squeal (Fig. 4D), equivalent to the distress call of many authors (see Thorpe 1961), is given when the bird is under restraint. Though adults do give the call when handled (Stefanski 1969) only

juveniles were heard to use it in this study. While still in the nest they gave it when I removed them for banding. The adults responded by flying rapidly back and forth across the nest area while giving loud separated "chickadee" calls, series "seep" calls, and "chit" calls (see below). Squeals may be given in a continuous, repetitive manner or at irregular intervals during the period of restraint.

Seep call.—This call is the most commonly heard of all the calls of the Boreal Chickadee and corresponds to the contact calls of Black-capped and Carolina Chickadees (Odum 1942, Brewer 1961). It is a structurally simple call (Fig. 4C) that both sexes give throughout the year.

It is given most often by members of a flock or pair feeding in close proximity, and much less frequently by single birds. This call is also the one most commonly used by males approaching a nest where the female is incubating or brooding. The female responds as she does to "chickadee" or partial "chickadee" calls.

Sharp "seep" call.—No recording of this call suitable for a spectrogram was obtained, but it sounds very like the "seep" call, except that it is louder and about five are given in an unbroken sequence.

The call seems to be equivalent to Odum's (1942) warning call and is given whenever a large bird flies overhead. Hawks were not common in the vicinity, but Common Ravens (*Corvus corax*) and Common Crows (*C. brachyrhynchos*) frequently elicited this response, while Gray Jays (*Perisoreus canadensis*), Brown Thrashers (*Toxostoma rufum*), and Common Grackles (*Quiscalus quiscula*) elicited a response less frequently. Occasionally small birds such as the Ruby-crowned Kinglet (*Regulus calendula*) or even conspecifics elicited these calls, usually by flying at high speed and landing suddenly in a tree near a chickadee. The Carolina Chickadee also used an apparently similar call (high "see" (Smith 1972)) when disturbed by both hawks overhead and small birds, including conspecifics.

The response of the flock or other member of the pair to this call is to fly immediately for cover if exposed, and then to sit there motionless and silent. Fledglings immediately stop begging when this call is given. The amount of time spent still and silent was very short and little if any crouching, as is seen in other *Parus* species (Hinde 1952), was noted. The reason for these limited responses may be that the species most often eliciting response, while having the general characteristics of aerial predators (large bird flying over), were quickly distinguished from predators by detailed differences in appearance.

Series "seep" call.—This call sounds similar to but is distinguishable

from the sharp "seep" call. The call was heard in situations of general arousal such as territorial conflicts and fledging of the young. It was always given in association with other calls, usually some variation of the "chickadee" call and/or "chit" calls.

Hiss.—This call (Fig. 1C) is used primarily in association with the snake display (Pickens 1928) present in all species of tits (Sibley 1955, Löhrl 1964) and is given when they are disturbed within a cavity. The call is given by both male and female Boreal Chickadees when trapped in cavities as well as by feathered young, and was also heard on three occasions from birds not in holes.

The visual component of the display, fluttering of the wings and snapping of the bill, was seen only once when a 17-day-old nestling used it. The call was heard on several other occasions when a bird was disturbed in a cavity, but in none of these cases was there enough light in the cavity to see any associated movements.

Outside of cavities the call was given by two different adults supplanting a Chestnut-sided Warbler (*Dendroica pensylvanica*) and a Magnolia Warbler (*D. magnolia*) respectively, when the warblers were near newly fledged chickadee young. The call was also given by one of a pair, both of which were simulating injured wings and leading a chipmunk (*Tamias striatus*) away from their nest where the young were giving begging calls. Pettingill (1937) described this injury-feigning display but made no mention of a vocalization. Odum (1941) described an injury-feigning display of the Black-capped Chickadee also without mention of a vocalization. Hinde (1952) described a call given by the Blue Tit (*Parus caeruleus*) during injury-feigning as similar but not identical to that given in the snake display.

"Chit" call.—Both sexes give "chit" calls very commonly throughout the year. They are used in a wide variety of situations and seem to indicate a moderate state of general arousal. They may be given when supplanting a conspecific or occasionally when supplanting a bird of another species, during bouts of musical or trilled calls (whether or not an actual conflict is occurring), and periodically before flight from one tree to another during foraging. The call is also uttered upon the sudden appearance of another bird, and it may be given after the sharp "seep" call when the latter is elicited by a medium-sized bird such as a jay.

Odum (1942) described a "chit" call for the Black-capped Chickadee that served as a warning call against ground predators. If this is a function of the Boreal Chickadee "chit" call, it is not at all obvious. Though no ground predators were observed in the immediate vicinity of foraging chickadees, birds foraging on the ground in the open would

occasionally give a burst of two or three of these calls and fly into a tree. The other members of the flock may follow, but they frequently seemed to ignore the call altogether.

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SUMMARY

The vocalizations of the Boreal Chickadee were studied in Algonquin Provincial Park, Ontario; 18 calls are described in their behavioral contexts and spectrograms are presented for 15 of them. Possible functions are suggested in some cases. Two calls (the musical and trilled calls) previously reported to be rare (Bent 1946) were found to be given frequently during certain stages of the reproductive cycle.

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