Responses of Black-capped Chickadee flocks to predators.—The antipredator strategies of avian flocks are of considerable interest from the standpoint of communication mechanisms and their effectiveness. Yet few detailed reports of reactions of flocks to predators are available. Here we report on the alarm system of Black-capped Chickadee (*Parus atricapillus*) flocks in response to several predators.

On 18 February 1975 at 1430 CST, Ficken was in a blind watching a flock of color-banded chickadees near a feeder at the University of Wisconsin-Milwaukee Field Station, Saukville, Wisconsin. Suddenly they gave some very distinctive high-pitched calls. We are very familiar with these calls, termed high zees, having heard them in response to predators on numerous occasions. The calls were elicited by a Northern Shrike (*Lanius excubitor*) perched 10 m from the feeder. The immediate response of chickadees to the first calls, given by AOPR (adult male), was to remain immobile with feathers sleeked. BJAO (immature) was 8 m from the shrike, AOPR 17 m. Both were in deciduous shrubs on exposed perches. Four other chickadees (two adults and two immatures) were 25–30 m from the shrike. The shrike remained perched in the same position for 7 min, and high zees were given at regular intervals in rapid bursts. After the shrike flew off, the chickadees continued calling and remained immobile for another 2 min. Then AOPR moved his head, scanned the environment, pivoted, and emitted several chick-a-dee calls. High zees ceased. Immediately other members of the flock began chick-a-dee calling and moving. BJAO, which had been closest to the shrike, was the last to move. After 2 min of chick-a-dee calling the birds began making short flights, calling diminished, and they visited the feeder. It is impossible to determine if the shrike was in a hunting mood, but its approach close to the feeder (where it was sighted on 3 successive days) and its scanning movements indicate it was hunting. That it did not approach a chickadee probably indicates the effectiveness of the predator alarm system and resulting immobility. Cade (1962, Wilson Bull. 74: 386) described the evasive behavior of a chickadee flock pursued by a shrike.

On 17 March 1974 at 0840 Witkin was recording chickadee calls at a feeder when a mink (*Mustela vison*) approached. Three chickadees were near by. SCAO (immature female) was in a deciduous shrub 2 m from the feeder. CPAO (adult male) the mate of SCAO, had landed on the feeder and was about to enter. Another chickadee, unidentified, was approximately 20 m from the feeder. The mink walked to within 10 m of the feeder and 8 m from SCAO. Upon sighting the mink, SCAO emitted a series of high zees (Fig. 1). CPAO immediately became motionless. The other chickadee's behavior was not noted. SCAO gave 25 of these calls in about 14 sec. The mink seemed oblivious to the chickadees and continued along its path. Approximately 20 sec after the last high zee, SCAO emitted four high tee calls, similar to those described by Smith (1972, Publ. Nuttall Ornithol. Club No. 11) for *P. carolinensis*. CPAO remained immobile for another 24 sec, then entered the feeder. The entire sequence, from spotting the mink to resumption of activity, lasted about 1 min. It seems unlikely that mink are important predators of chickadees, although other mustelids prey on parids. Weise (pers. comm.) reports that when a weasel (*Mustela* sp.) approached and moved back and forth directly under a feeder where chickadees were feeding chick-a-dee calls were given in the manner typical of mobbing and high zees were not uttered. On several occasions, chickadees have been approached by grey squirrels (*Sciurus carolinensis*) and red squirrels (*Tamiasciurus hudsonicus*) as close as 1 m without any noticeable alarm reaction. These observations may indicate that chickadees can distinguish between mammalian predators and nonpredators.

High zees were also recorded on the initial presentation of a tethered Saw-whet Owl (*Aegolius acadicus*) at a feeder (Apel pers. comm.). On several occasions these calls were given when Sharp-shinned Hawks (*Accipiter striatus*) flew to within 40 m of a chickadee flock. However, a perched Goshawk (*A. gentilis*) elicited the mobbing chick-a-dee calls, and soaring Red-shouldered Hawks (*Buteo lineatus*) within 50–100 m elicited no reaction. Thus some predators tend to elicit high zees, but in other situations none are given.

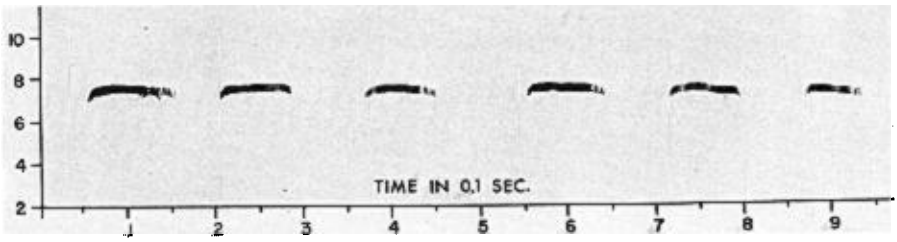

Fig. 1. Spectrogram of high zees given in response to a mink. (Recorded with a Nagra 4.2 L tape recorder; analyzed on a Kay 6061B Sona-graph at 150 Hz band width.)

TABLE 1
CHARACTERISTICES OF HIGH ZEES[1]

Context	No. calls measured	Highest frequency (kHz)	Frequency range (kHz)	Duration (sec)
Sharp-shinned Hawk	3	8.87 ± 0.2	0.28 ± 0.06	0.10 ± 0.03
Saw-whet Owl	11	8.55 ± 0.19	0.42 ± 0.11	0.10 ± 0.02
Mink	25	7.76 ± 0.17	0.35 ± 0.12	0.07 ± 0.01

[1] Amplitudes were analyzed with a B and K level recorder type 2305. The dB measured at 1 m was 55.8 + 2.4, −3.3 for 25 mink calls. Amplitudes in dB were converted to N/m^2 for calculation of mean and SD, then converted back to dB (re 0.00002 N/m^2).

The suddenness with which the predator appears in the area may be a factor in influencing the type of reaction (Weise pers. comm.).

The characteristics of high zees are indicated in Table 1. The highest pitch of the call varied in different situations (the calls were lower pitched and of shorter duration in response to the mink). This call is similar to that of other passerines in similar situations (Marler 1957, Behaviour 11: 13). The call has characteristics that make it difficult for a predator to localize the caller: no sharp onset or ending, high pitched, and covering only a narrow frequency range (Marler 1955, Nature 176: 6). Marler and Hamilton (1966, Mechanisms of animal behavior, New York, Wiley) indicate that in other species the call is given only to aerial predators; but in the chickadee at least, it is elicited by a variety of predators regardless of whether they are flying. Marler and Hamilton (loc. cit.) note that birds usually mob perched predators, but that when a hawk flies over they move to cover if in the open and freeze. A more effective strategy for a bird with a predator in close proximity might be to call and freeze immediately.

The role of individuals within the flock in generating and terminating predator alarm is of interest. AOPR was the dominant male at the feeder and for several years had a breeding territory encompassing the feeder (Weise pers. comm.). Of the 8 cases in which we know the identity of the first to give the alarm, 7 involved males and 4 were AOPR. On the two occasions when we noted complete sequences of activities and AOPR was present, his chick-a-dee calls terminated the bout of high zees after the predator left and seemed to serve as an "all clear" signal eliciting movement of others. Evidently one bird assesses the situation and his signal affects the behavior of other members of the group. These observations suggest that certain adults may be especially important in alerting the group and in signaling the resumption of normal activities.

An important selection pressure for flocking is the antipredator strategies of a flock vs. solitary individuals. This is certainly borne out by the observations that we report. A solitary individual that did not immediately spot a predator would probably be its next meal. However, flock members may benefit by others first sighting a predator. In winter, chickadee flocks typically consist of about four to eight individuals, both adults and immatures (not the offspring of the adults of the flock) (Weise pers. comm.). This flock structure seems especially to benefit the young and inexperienced birds that associate with adults. A more difficult evolutionary question is why adults tolerate the younger birds as kin selection does not seem to be operating.

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Predation on Rufous Hummingbird by Wied's Crested Flycatcher.—Reports of other birds preying on hummingbirds are rather uncommon in the literature. Among these reports are those of Lowery (1938, Auk 55: 280), Wright (1962, Auk 79: 112), Peeters (1963, Wilson Bull. 75: 274), and Mayr (1966, Auk 83: 664). With the exception of Wright's account, the other reports of hummingbird predation have involved raptors. Wright saw a male Northern Oriole (*Icterus g. galbula*) seize and peck a male Ruby-throated Hummingbird (*Archilochus colubris*) to death while both birds were feeding on blossoms.

Apparently the specific food habits of the Wied's Crested Flycatcher (*Myiarchus tyrannulus*) are unknown. Although stomach analysis data are absent for *M. tyrannulus*, all *Myiarchus* are known to hawk and forage for invertebrates. The normal prey of *M. tyrannulus* is undoubtedly much smaller than a hummingbird (W. E. Lanyon pers. comm.).

On 19 July 1974 at Cave Creek Ranch near Portal, Arizona I watched a Wied's Crested Flycatcher kill a male Rufous Hummingbird (*Selasphorus rufus*) at a hummingbird feeder. A Wied's Crested Flycatcher