

SELECTED VOCALIZATIONS OF THE COMMON CROW

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BIO-ACOUSTICS has developed rapidly in the past decade as a tool in the study of communicative mechanisms in wild birds (Hinde, 1969). The Common Crow (*Corvus brachyrhynchos*) is an ideal experimental subject for this type of research. Johnston (1961: 15) remarks how even the casual observer of crow behavior can detect changes in pitch and rate of call delivery, an indication of the communicative potential and behavioral complexity of crow vocalizations. In a study of the functional anatomy of the syrinx, Chamberlain et al. (1968) found the Common Crow to be morphologically capable of producing a significant variety of notes.

Bent (1946: 247-249) describes the characteristic vocalizations of the Eastern Common Crow (*C. b. brachyrhynchos*), citing observations by Hoffman (1904), Knight (1908), Wright (1912), Allen (1919), Townsend (1923), and Forbush (1927). Allen (1919) relates crow notes to time rhythms, triplets, and other periodic combinations. Good (1952) discusses the meanings of a number of crow vocalizations including: the rally call, given after sighting or hearing a crow predator; the squalling cry, uttered by a crow captured by a predator; and the scolding call, given by adult crows during the nesting season when the young are threatened. The alarm, assembly, ordinary cawings, and begging cries of the young have been tested with American and French crows, both in France and the eastern United States (Frings et al., 1958). These authors tabulated positive and negative phonotactic responses to calls; they also tested crows with the calls of other species, in many cases without observable effects on the crows' movements.

Davis (1958) made audiospectrographic analyses of typical calls of various species of North American and Mexican crows, on the basis of which he described the crow of Sinaloa, Mexico, as a new species, *Corvus sinaloae*. Chamberlain (1967) intensively studied the sounds produced by the Common Crow and the environmental and behavioral context in which each call occurs in the wild. An annotated magnetic tape of the vocalizations discussed in this paper is available through interlibrary loan of the thesis and from the Laboratory of Ornithology at Cornell University.

Thompson (1969) shows the cawing of Common Crows displays two kinds of organization, structured and unstructured. He has evidence that the rigid, idiosyncratic structured pattern identifies the individual crow; the unstructured pattern reflects the degree of the individual's excitement. On this basis, our paper deals primarily with unstructured vocalizations,

and only includes six sounds (contact call, announcement call, duet notes, mimicry, courtship sounds, and immature hunger and feeding calls) that may determine individual recognition. We did not analyze crow vocalizations for the stable and predictable components necessary for species recognition and distinctiveness.

METHODS AND PROCEDURES

We recorded selected vocalizations of wild and tame crows and noted the environmental context and behavior accompanying each. Decoy mounted crows and Great Horned Owls (*Bubo virginianus*) were used when appropriate to elicit calls requiring their presence. Selected crow calls and the distress calls of three sympatric avian species were transcribed onto continuous loop tapes from the original field tapes. Loop tape tests were made from an automobile using a Wollensak 1700 T recorder with a 10-watt amplifier and a U. S. Army surplus cone speaker powered by a 12-volt car battery. The speaker was mounted on a ski rack on top of the automobile during field tests. Test tapes were broadcasted to crows in the field, with the automobile and testing equipment hidden as well as conditions allowed from direct sight of the crows.

Crow responses to tests were classified, in part, by the following phonotactic system derived from that of Frings et al. (1958):

- Class I: Specific predicted response of crows within the estimated hearing range.
- Class II: Only part (quantified as much as possible by field observation) of the crows within the estimated hearing range responded as predicted, while the remainder did not respond at all.
- Class III: Only part of the crows within the estimated hearing range responded as predicted, while the remainder reacted in other than the predicted manner.
- Class IV: No response among crows within the estimated hearing range.
- Class V: Unpredicted responses by crows within the estimated hearing range.

This ranking scheme was used for field classification of behavioral responses to broadcasts of five crow vocalizations (Table 1). The expected response was predicted prior to broadcast. Actual responses were compared to the predictions as a further confirmation of the context in which the vocalizations were recorded and tested. Vocalizations failing to elicit a response were tested repeatedly to establish the specific context under which they were given.

The reactions to field tested vocalizations were also classified as "positive" (+) or "negative" (-) phonotaxis and "other" responses. "Positive" phonotaxis was recorded when crows responded by flying directly to the broadcast source. "Negative" phonotaxis was recorded when the response was a direct flight away from the broadcast source. The balance of responses were tabulated under "other" (see tabular documentation in Chamberlain, 1967). Sounds that caused overt responses among crows were classified "primary" and nonresponse sounds were designated as "other."

Three tape recorders were used in the field to record Common Crow vocalizations: A Wollensak model 1700 T with a built-in converter and a Wollensak hi-impedance, omnidirectional, crystal microphone (50-8,000 c.p.s.) along with a Turner model 58, omnidirectional, hi-impedance microphone; a battery operated Kudelski Nagra III

TABLE 1
CLASSIFICATION OF CROW RESPONSES TO CROW VOCALIZATIONS TESTED AND RANKED¹

Crow vocalization	Prediction	Class of response					Total tests
		I	II	III	IV	V	
Assembly call	Aggregation to	27	2	1	-	-	30
	sound source	91%	6%	3%	-	-	
Simple scolding call	Aggregation to	12	3	-	-	-	15
	sound source	80%	20%	-	-	-	
Dispersal call	Dispersal from	8	-	1	-	3 ²	12
	sound source	67%	-	8%	-	25%	
Squalling call	Aggregation to	22	-	3	-	-	25
	sound source	88%	-	12%	-	-	
Moribund call	Aggregation to	5	2	4	2	7	20
	sound source	25%	10%	20%	10%	35%	

¹ Extensive tabular documentation of crow responses in Chamberlain (1967).

² One test included 21 Fish Crows.

with a Nagra III omnidirectional microphone; and a Hitachi transistorized portable model TRQ-370 with a Hitachi model TRQ-370 unidirectional microphone was used for short range recording. A 39-inch parabolic reflector was used to pick up distant crow vocalizations and a 26-inch snow coaster disc to tape those nearby. Missilgrams made on a Missilyzer manufactured by the Kay Electric Company were used to illustrate call differences.

PRIMARY VOCALIZATIONS

ASSEMBLY CALL

The assembly call is an intense and raucous mobbing call containing long notes (wide band width of individual call notes) (Figure 1A), and is given when crows see or hear nearby crow predators, e.g., the Great Horned Owl, Red-tailed Hawk (*Buteo jamaicensis*), or red fox (*Vulpes fulva*). The assembly call has the apparent function of calling together a group of crows to drive predators away from places the crows frequent, such as nesting, roosting, or feeding areas. The Common Crow assembly call attracts to the sound source Common and Fish Crows (*Corvus ossifragus*) within hearing range (Table 1).

Assembly calls are given throughout the year. Field tests and/or observations were made during all months of the year. Six night visits to Virginia crow roosts revealed that Common Crows give assembly calls at night. These night observations are the basis for all following references to night vocalizations.

When giving the assembly call from a perched and erect position, the Common Crow holds the contour and wing feathers close to the body. The tail is retained approximately 1 inch below the body plane, and the

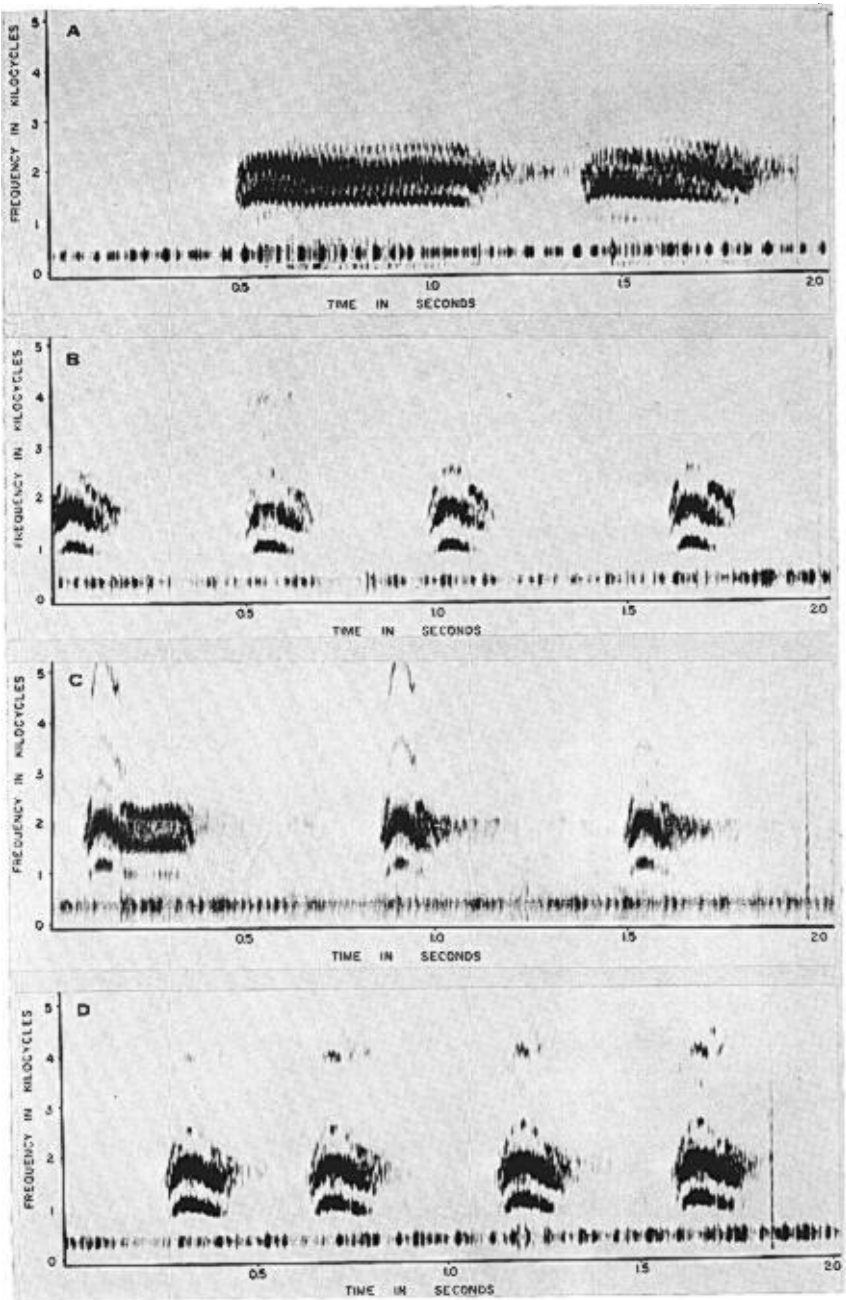


Figure 1. A, assembly call; B, simple scolding call; C, modified scolding call; D, alert call. (Certain vocalizations are illustrated more than once to show variation.)

rectrices spread laterally about 2 inches beyond the tail's closed position. The tail flicks up and down below the body plane during the call, and the wings move rapidly up and over and back and down to a closed position. Crows emitting assembly calls while diving at an aerial predator have a dihedral wing angle, and often extend the legs with claws open in the manner of a raptor closely pursuing prey. Crows responding positively to the assembly call fly with rapid flapping wings.

SIMPLE SCOLDING CALL

The primary function of the simple scolding call (Figure 1B) is to announce the presence and location of a crow predator. Good (1952) describes this call. One of the three mobbing calls the Common Crow uses, the simple scolding call is more sharply staccato and continuous and not so raucous as the longer-noted assembly call, although raucous notes are common to both calls. The simple scolding call is given when a crow hears an unseen predator, and also while approaching a distant predator it can see. At close range the scolding vocalization is abandoned for assembly calls, which are more effective in driving away a crow predator.

Simple scolding calls are delivered at various degrees of intensity depending on the type of predator, its distance from the crow, its movements, and the season of the year. For example, Common Crows give intense and rapid scolding calls when they hear hoots of the Great Horned Owl, but less rapid and intense calls when they hear the clucks of the Sharp-shinned Hawk (*Accipiter striatus*). Apparently this variation in calling occurs because the Great Horned Owl is a crow predator in winter roosts and spring nesting grounds, whereas the Sharp-shinned Hawk rarely preys upon crows.

Given throughout the year, day or night, Common Crow simple scolding calls attract both Common and Fish Crows to the sound source (Table 1). Crows do not remain near the test source of the simple scolding call for as long a time as with the assembly call. They dispersed before the field tests ended in 5 of 15 broadcasts. Some birds continued to repeat simple scolding calls up to 10 minutes after field tests stopped.

When giving the simple scolding call perched and erect, the Common Crow moves the head up and down and forward and backward. When the head moves toward the tail and up, the wings flick up and away from the body. The beak closes when the head moves forward and down and opens when the head moves back and up.

Crows used alternate flapping and gliding flight when approaching simple scolding calls during 4 and rapid flapping flight in 11 of 15 field tests.

MODIFIED SCOLDING CALL

The modified scolding call is a mobbing call and is functionally similar to the simple scolding call, which it closely resembles, but all its notes are inflected (Figure 1C). It is uttered throughout the year, day or night, in response to the vocalization or distant sighting of crow predators. Postures accompanying this call are nearly identical to those of the simple scolding call. In five tests crows did not approach so rapidly or remain near the sound source so long as in response to the simple scolding call.

ALERT CALL

The conversational alert call expresses the crow's awareness of danger perceived by auditory or visual means. Alert signals vary in intensity, frequency, duration and number of notes (Figures 1D, 2A), and also vary in delivery according to the immediacy and type of danger. For example, alert notes given by a ground-feeding crow surprised by a predator are sharp, intense, and rapid. Those uttered by a crow that sees a hunter approaching at a distance are less sharp, less intense, and spaced at greater intervals. The distinctive feature that separates the alert call from simple scolding is the number of notes per call. The simple scolding call has an unlimited number of notes per series, whereas the alert sequence rarely has more than seven notes, and generally six or less. The alert call is often delivered more rapidly than the scolding call. Alert calls did not provoke a dispersal response among crows tested.

Some birds indicate the type of predator with their alert calls, and some have specific calls to distinguish aerial from ground predators. Collias and Joos (1953) note that the hawk call of the Domestic Fowl (*Gallus domesticus*) is an intense, harsh scream, but that for a dog or man is a cackling sound. Catbird (*Dumetella carolinensis*) alert calls change abruptly from short notes to protracted catlike "meows" as an intruder approaches the nest (Collias, 1960: 369). We found no such differences in crow alert calls, and 12 tests suggest that the number of notes per crow alert series does not convey shades of meaning or degree of danger.

The function of the alert call is to warn crows of nearby or distant danger. Crows respond to this signal by emitting alert, assembly, modified or simple scolding calls, flying up into trees if on the ground, and flying away from and back to an arboreal perch. Also, perched crows show nervous movements such as rapid wing and tail flicking and frequent defecation. The postures associated with the alert call are similar to those for the simple scolding call. In 12 of 17 tests, crows responded positively to the alert call by giving assembly and simple scolding calls while apparently searching for the nonexistent predator.

DISPERSAL CALL

The dispersal call (Figures 2B, 2C) is the extreme degree of the alert call. Its notes are generally sharper (thinner band width), and they are delivered closer together than alert notes. The first note is often inflected (Figure 2B). The variability in sound intensity between alert and dispersal signals was not measured, although we suspect that dispersal calls are delivered with greater volume than alert calls. The dispersal call made Common Crows fly directly away from the test area during eight broadcasts. In three tests Common Crows came to the call giving mobbing calls and apparently looking for a predator (Table 1).

Dispersal calls are given by crows that sense immediate danger, such as a hunter's sudden appearance nearby. Crows in roosts commonly give one after sighting danger, say a Great Horned Owl. The number of notes in a dispersal call does not appear to convey different degrees of danger to responding crows. We believe this is the vocalization Frings and Frings (1957) refer to as the alarm call consisting of "four short notes." We found the dispersal call to vary in note number. In eight tests of dispersal calls scores of crows rose out of trees and flew high in the air, massing in a circling flock and giving simple scolding and assembly calls.

Frings and Frings (1964: 58) state, "If a crow suddenly flies away from the group without making any sound, the others usually follow. It has spread an alarm—the fastest and safest way." Chamberlain made a supposed "sentry" perched above a flock of ground-feeding crows fly on four different occasions during this study without giving a dispersal call. In each case the flock remained on the ground until Chamberlain came within their sight.

SQUALLING CALL

Squalling calls are given by crows struggling to escape from a predator such as a hawk or fox, and can be produced by holding an immature or adult crow upside down by its legs and shaking it (Figures 2D, 3A). It varies in intensity, frequency, tempo, and duration with the gravity of the situation. For example, a crow that is shaken vigorously delivers squalling notes more intensively, sharply, and rapidly than one shaken slowly. Squalling calls are generally higher pitched and have more of a wailing quality than other crow vocalizations.

Common and Fish Crows respond to immature and adult Common Crow squalling calls by gathering rapidly to the sound source (Table 1). At night Common Crows will fly to squalling calls near a roost. One January night in western Virginia, crows gave assembly and simple scolding calls over the sound source before settling back into conifers some

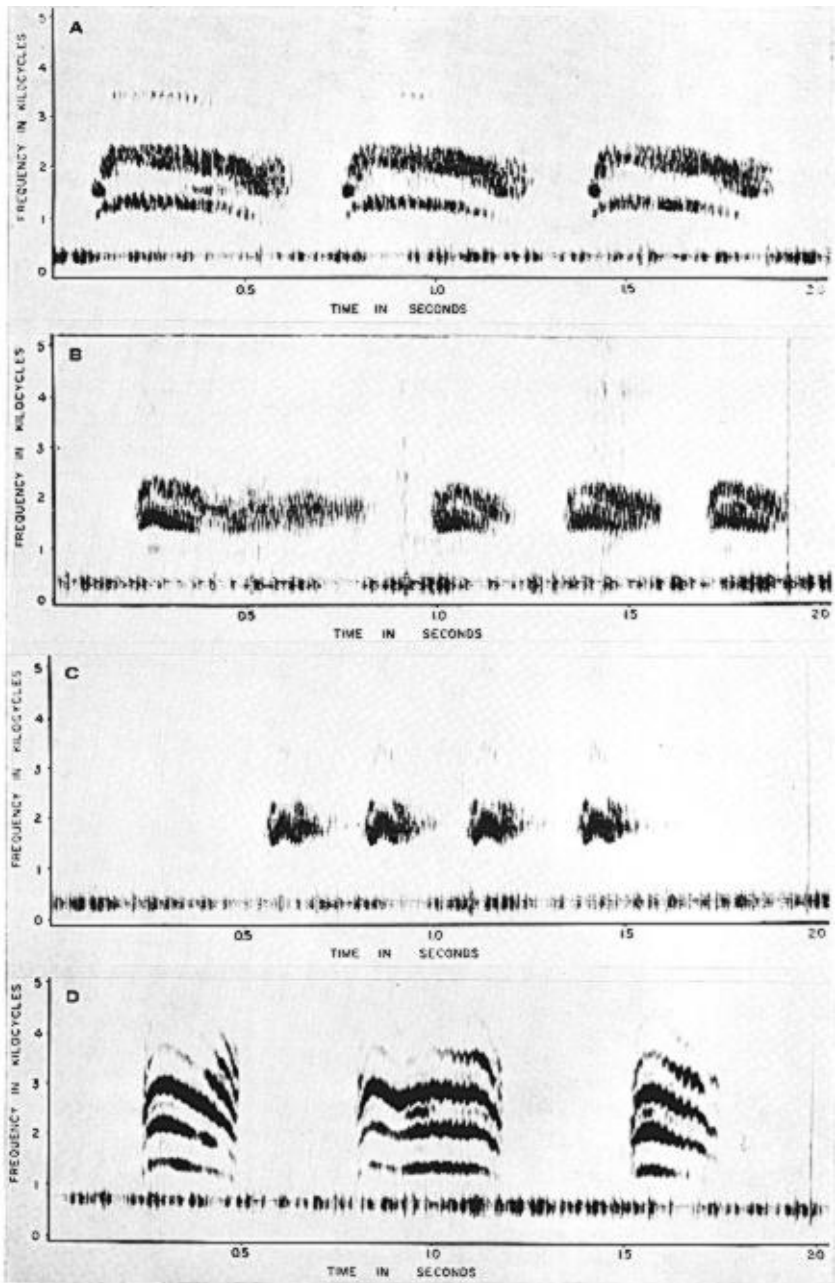


Figure 2. A, alert call; B, dispersal call; C, dispersal call; D, squalling call.

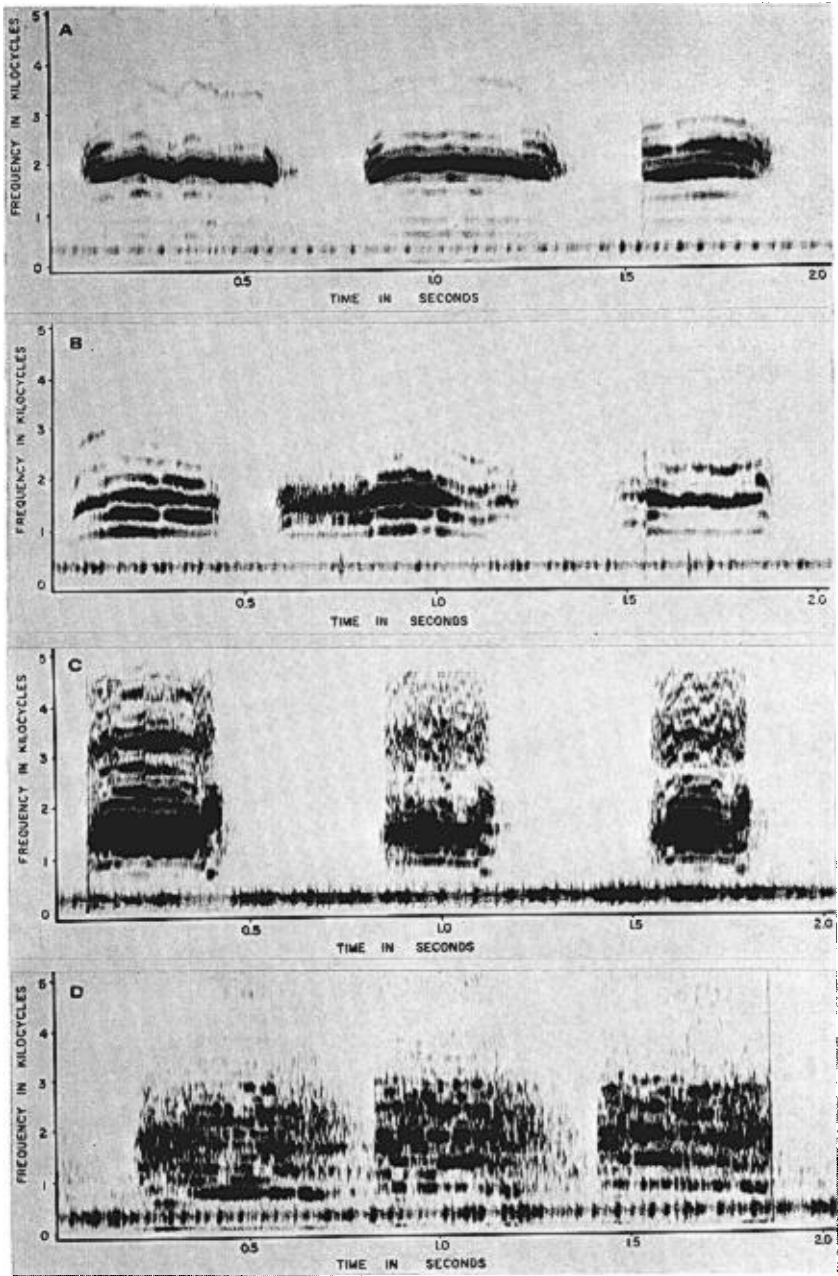


Figure 3. A, squalling call; B, squalling call broadcasted in reverse at the speed originally recorded; C, moribund call; D, threat call.

200 yards from those occupied before the test. Broadcasting distress calls of the European Jackdaw (*Corvus monedula*) elicited a negative response at night in French crow roosts, causing birds of several species to desert the roosts permanently (Frings et al., 1958).

Crows respond to squalling notes with assembly, modified, and simple scolding calls. They apparently approached the sound source intending to mob the crow predator. We broadcasted adult squalling calls in a crow roost in western Virginia in January with the tape reversed. The crows responded by aggregating to the sound source in spite of tape reversal (Figure 3B).

MORIBUND CALL

The moribund call (Figure 3C) is the extreme squalling call of the Common Crow and is emitted by a dying crow. Moribund calls are not delivered as rapidly or loudly, but are more raucous and gurgling than squalling notes. Because of its weakened condition while giving this call, a crow does not struggle or fight off a predator. The moribund call is a definite communication produced by the dying bird and not a sound produced mechanically or incidentally in the process of dying.

Crows showed variable responses to the moribund call tested in the field. In 20 tests, crows exhibited positive phonotaxis in 5, negative phonotaxis in 7, and made 8 other responses (Table 1).

THREAT CALL

The threat call (Figure 3D) is the most variable of the Common Crow's vocalizations. Threat calls are often given as screams, cackles, staccato and rattling notes, coos, and a variety of other sounds. They occur in a highly variable context and are often indescribable. A crow may utter one when under attack or threat, or when attacking or threatening a predator or another crow. Crows responded to five field tests in an unpredictable manner.

Threat calls are the commonest notes heard among roosting Common Crows. The birds compete with one another for roosting perches. Incoming crows try to dislodge those already roosting, and both the attackers and those attacked utter threat calls. The apparent function of these signals is to make the opponent retreat.

Good (1952) describes growl calls given by Common Crows diving or pursuing a winged predator at close range. Prior to diving at a flying predator, a crow will first hover on beating wings, then start an erratic descent with wings closed in a dihedral over the rump. In seven observations the legs were extended with open claws, and a type of threat

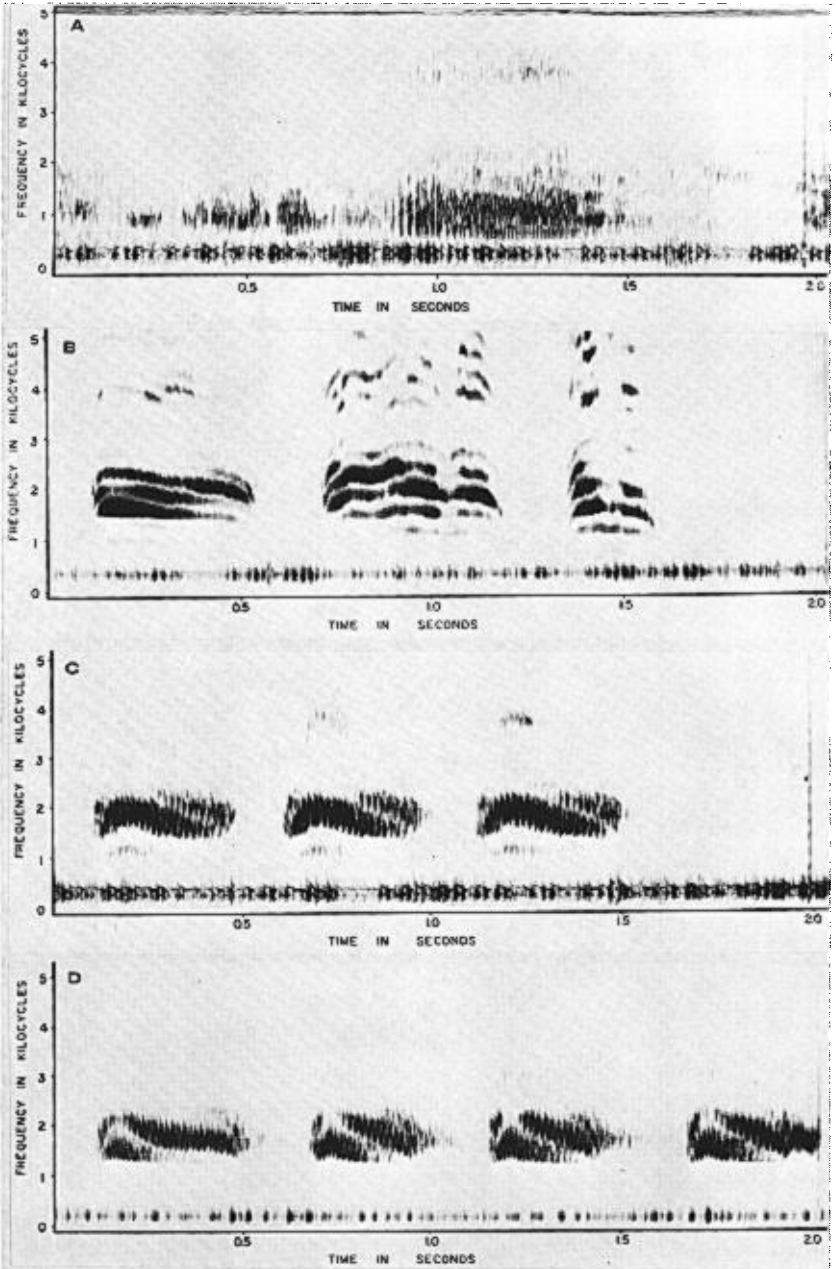


Figure 4. A, growl call; B, immature hunger and feeding call; C, contact call; D, announcement call.

vocalization (or growl call) was emitted when the crow passed close to the predator (Figure 4A). Crows while mobbing a flying or perched raptor give assembly, simple and modified scolding calls, but supplant them with threat calls when close to or within striking distance of a raptor. One April Chamberlain heard an adult Common Crow emit threat signals when diving upon a Turkey Vulture (*Carthartes aura*) that came near its nest containing three fledglings in west central Florida.

During threat vocalization while perched, the neck, nape, throat, and head feathers are erect and appear ruffled. The wings move back and up when the bird rears back while under attack or when threatened. The wings may be drooped and spread, and the head lowered between the legs prior to attacking or being attacked.

IMMATURE HUNGER AND FEEDING CALLS

Immature Common Crows gape and give these calls (Figure 4B) when stimulated by hunger or the sight of food, by seeing or hearing objects associated with food, or by a combination of any or all of these. Hunger calls elicit variable responses among crows in the field. Frings et al. (1958) states that "begging cries of young nestlings" had no observable effect on the movements of crows when field tested. In 31 tests we obtained 14 positive, 9 negative, and 13 other responses to hunger calls broadcasted in the field (8 tests showed two classes of responses).

The hunger call resembles squalling notes, but its individual notes are not so protracted and wailing. The feeding call contains a number of rapid but clearly distinguishable notes delivered by the young while swallowing food after uttering hunger notes while gaping. Hunger calls are subject to different degrees of delivery, dependent on the amount and proximity of food in relation to the calling bird. The stronger the stimulus, the faster and more intense the delivery of the high-pitched notes.

Muir (1954) noted that unfed young Tawny Owls (*Strix aluco*) call more often than fed ones, thereby expressing their degree of hunger; he suggests this behavior may bring about a more even food apportionment among the young by adult owls. We noted this same phenomenon in both tame and wild Common Crows. Immature hunger calls also function as location notes, helping parent crows reestablish contact with their young. Pet crows often associate food with a human voice when talking accompanied hand feeding; these birds stop their insistent hunger calls when the owners are concealed and quiet, but promptly resume gaping and the accompanying vocalizations when they see or hear their owner.

Many bird species are known to have food calls given by the adult that stimulate feeding responses in the young, such as the Yellow Warbler

(*Dendroica petechia*) and Least Flycatcher (*Empidonax minimus*) (Collias, 1960: 369). We detected no specific vocalization given by parent crows to their young that could be interpreted as a food call. Nestling crows respond with hunger calls to virtually all vocalizations of adults near the nest, including the assembly, simple scolding, alert, and dispersal calls.

While giving hunger calls in or out of the nest when perched, immature Common Crows move their wings rapidly up and down away from the body. The tail also moves up and down during begging. The bright-red mouth is evident during the period of open-mouthed food begging.

CONTACT CALL

The components of group movements by Common Crows are assembly, preparation for movement, initiation, liaison while moving, and cessation. Land birds that travel in flocks appear to place heavy reliance on contact notes between individuals. Marshall (1964) lists a "seep note" by the Brown Towhee (*Pipilo fuscus*) that mated birds use to maintain contact with each other when they are a short distance apart but hidden from each other. Odum (1942) notes that the "chick-a-dee-dee-dee" call of the Black-capped Chickadee (*Parus atricapillus*) is used to maintain contact when the flock is scattered. Contact notes that function to keep the flocks together are common in migrating crows (Figure 4C). This call characteristically contains three, four, or more notes; but, commonly a four-noted sequence is uttered by one crow in note pairs. Common Crows maintain group cohesion by answering each other with identical or similar contact notes, particularly in roosts and in migrating flocks when pairs become separated.

Crows emit contact calls while in flight or perched. When perching, the associated postures are similar to those used in simple scolding calls.

ANNOUNCEMENT CALL

Announcement calls (Figure 4D) are used by individuals flying to join an aggregation of Common Crows, such as those at feeding grounds or roosts and function as a form of recognition and contact. These calls are extremely variable in quality of delivery, and often closely resemble simple scolding and assembly calls, but are usually much shorter. Common Crows give these calls when in gliding or flapping flight. During gliding flight the bird descends at approximately 45 degrees with wings held in a dihedral position, the tail level with the body or angled dorsally. On five instances, an answer was received from a flock member(s) before the bird resumed noisy, flapping flight.

DUET NOTES

These notes (Figure 5A) were heard between two tame, caged adult Common Crows separated by an opaque partition. Both birds appeared to be males. These two crows developed four recognizable duet combinations including rattling notes and cawing variations that they used to establish mutual recognition when out of each other's sight. Apparently paired wild crows also use these duets for individual recognition and contact in roosts or large feeding flocks.

Many bird species practice duetting, generally between pairs (Thorpe and North, 1965). Common Crows are no exception: one crow emits a certain vocalization that stimulates another crow to answer in kind. Five duets were heard between five different pairs of wild crows in roosts during this study.

COURTSHIP VOCALIZATIONS

The observation and recording of vocalizations associated with precopulatory behavior in the Common Crow were too limited to justify reporting here. Bent (1946: 227-229) describes the behavior and vocalizations accompanying Common Crow mating.

OTHER VOCALIZATIONS

Juvenile notes.—Immature crows in their first year have a variety of juvenile notes that are apparently practiced while gaining experience prior to actual use (Figure 5B). An immature Common Crow Chamberlain heard in July emitted juvenile notes resembling assembly calls. In west central Florida we recorded an immature Common Crow in April trying to give the screams peculiar to the Florida population of the Common Crow (*C. b. pascuus*) (see below). Juvenile notes are given with the head lowered and beak open. The wings flick up and away from the body and down to a closed position.

Contentment notes.—Five tame crows in southwestern Virginia gave contentment notes when they had fed to capacity, were having their throat feathers stroked, or were otherwise apparently content. These notes are soft and plaintive to the ear (Figure 5C). While emitting them the bird sits low on a perch in contrast to the erect position during the alert call.

Rattling notes.—Rattling notes are heard within crow roosts as well as from flocks of feeding and migrating crows (Figure 5D). This vocalization generally contains 5-20 sharply delivered, staccato notes in a single utterance, somewhat like a rapid woodpecker tapping. Rattling notes are given by apparently paired crows when diving near each other, while descending into a roost, or when entering a diurnal feeding flock. Clucking

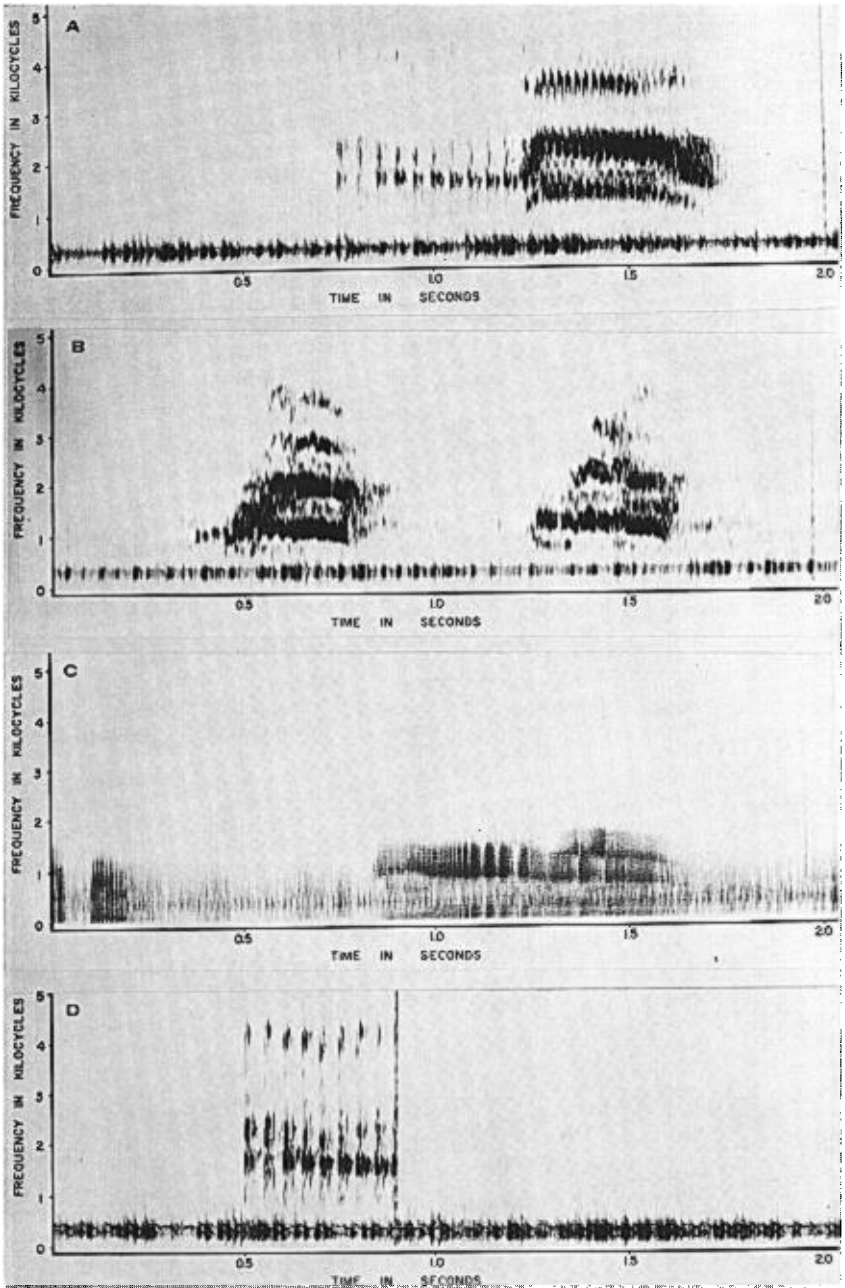


Figure 5. A, duet notes; B, juvenile notes; C, contentment notes; D, rattling notes.

sounds, intermediate between rattling and threat notes, are uttered within feeding and migrating flocks. In July in southwestern Virginia, a juvenile crow gave hunger calls while approaching an adult crow in a tree, to which the adult responded with rattling notes. Given by both male and female Common Crows in captivity, rattling notes elicited no observable responses from wild crows when field tested.

Rattling notes may be one of the male courtship calls addressed to the female prior to mating in the spring. The female answers with submissive vocalizations similar to those immature Common Crows give when begging for food (Townsend, 1927). Townsend states that rattling notes may also be emitted by males coming into sexual maturity for the first time in their second fall while aerially pursuing females. One September in western Virginia, Chamberlain watched at least 14 Common Crows of unknown sex and age erratically pursuing and diving upon each other while constantly giving rattling and threat calls.

Wow-wow notes.—Wow-wow notes (Figure 6A) were given repeatedly by three adult tame crows but were never heard from crows in the wild. This sequence sounds like a dog yelping, but was not believed to be mimicry because it was heard from birds in New York and Virginia. No function could be associated with this vocalization.

While giving wow-wow notes, the head is moved up and down as if bowing, the beak is opened and closed, the tail feathers are spread laterally, the wings move up and away from the body and down to a closed position, the nictitating membrane covers the cornea, and the belly shakes noticeably.

Carr-carr notes.—Carr-carr notes are protracted caws (Figure 6B). These were recorded in September at a crow roost in western Virginia. We saw no response to them by roosting crows. We twice heard three-syllabled carr-carr notes uttered near an active crow nest by an adult crow in May, and once by an adult crow in a flock of eight crows perched in elm trees in September, both in western Virginia. No response or particular context was noted in either instance.

Whisper notes.—Whisper notes, as implied, are muted. We recorded an adult crow giving whisper notes (Figure 6C) resembling alert calls in March in western Virginia. Staccato whisper notes also were heard in a crow roost one February in southwestern Virginia. No response was noted in either instance.

Coo notes.—In Myakka River State Park, Florida, Chamberlain walked near a family group of Common Crows in April. The two adults uttered assembly and simple scolding calls, and one adult gave a two-noted high pitched "coo-coo" (Figure 6D) between these mobbing calls. Nearby crows made no apparent response. A coo note was again heard in the

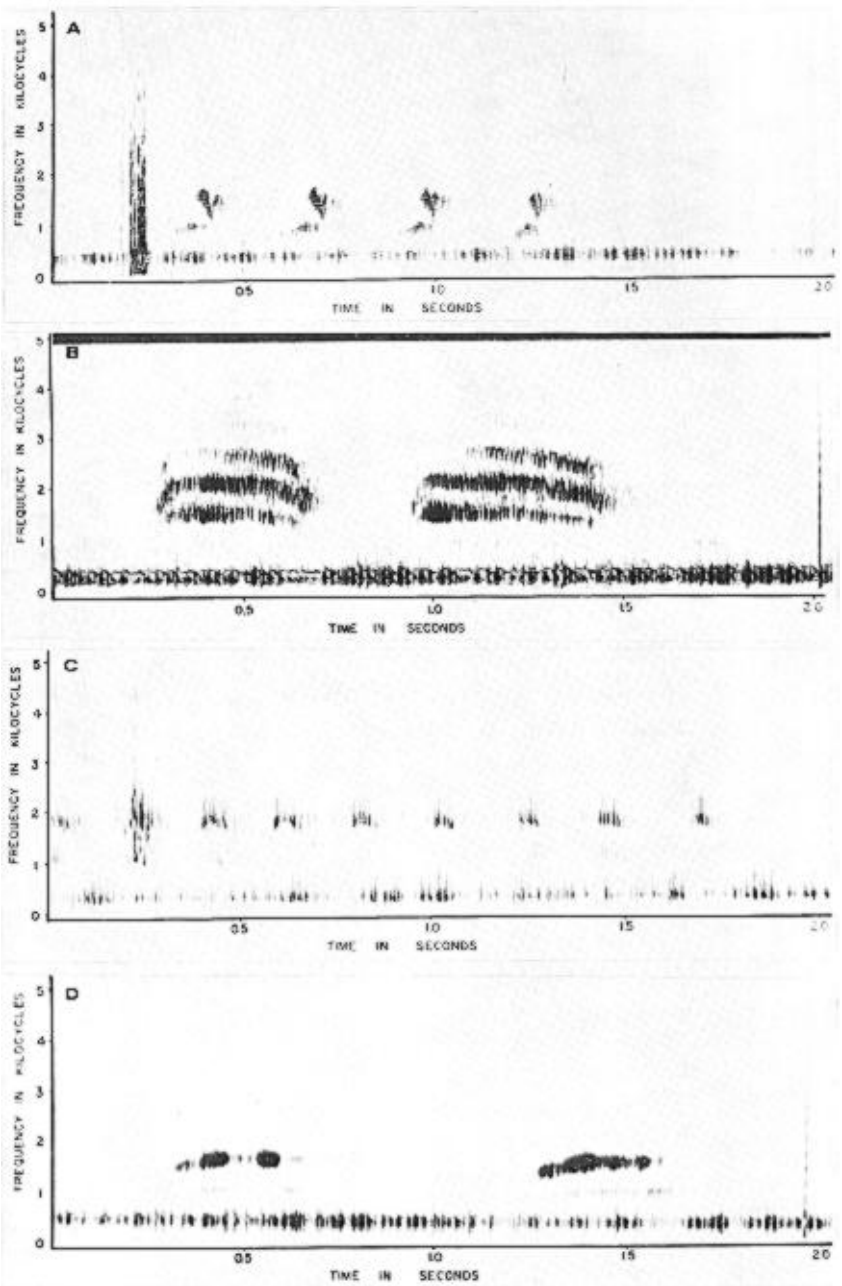


Figure 6. A, wow-wow notes; B, carr-carr notes; C, whisper notes; D, coo notes.

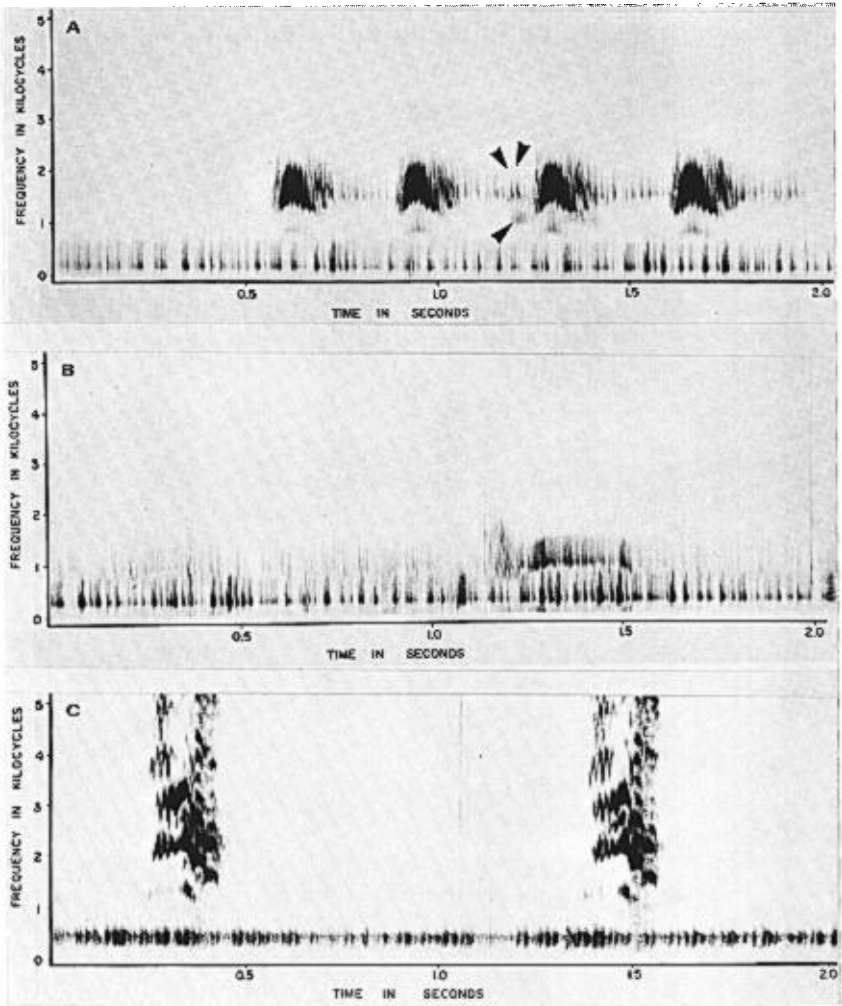


Figure 7. A, organ notes (delineated by arrows next to a scolding note); B, wah-oo notes; C. *C. b. pascuus* screams.

same locale, given by an adult crow prior to an alert call directed at the observer. Coo notes may be associated with danger. Similar sounds have been heard from tame crows when seeing strange people, dogs, etc. Townsend (1927) describes apparently similar coo notes as one of the male precopulatory vocalizations.

Organ notes.—Chamberlain used a crow call to lure crows to a mounted Great Horned Owl in western Virginia in March. The crows gave simple scolding and assembly calls while mobbing the decoy. During the mobbing,

one crow with a flock perched in a cluster of conifers uttered at least 10 high-pitched organ notes (Figure 7A). No particular response by individual crows perched near the crow uttering organ notes was seen. Organ notes may be similar to coo notes in that they are associated with danger.

Wah-oo note.—In southwestern Virginia a crow was recorded giving a single wah-oo note in a roost in February approximately 10 minutes before sundown (Figure 7B). On 12 occasions during the study, crepuscular crow sounds similar to wah-oo notes were heard, but not taped. Roosting crows emit many sounds not encountered elsewhere, including sounds associated with threat. For example, one adult crow in a flock of crows flying into a roost in western New York uttered high-pitched, four-syllabled chipping notes.

C. b. pascuus screams.—Individuals in the Florida population of the Common Crow commonly produce intense, raucous screams (Figure 7C). Crows near the sound source make no apparent response.

Bent (1946: 262) states that several observers have reported a vocalization peculiar to the Florida Crow. Mortimer (1890) heard sounds like the cries of a cuckoo (*Coccyzus* sp.). These may have been similar to the crow screams we heard in Myakka River State Park, Florida.

Mimicry.—Common Crows often mimic other birds and mammals. Forbush (1927) heard a crow give an excellent imitation of the whine of a dog. He also heard crows emit a varied assortment of notes, some of which were imitations, such as the cry of a child, the squawk of a hen, and the crow of a young rooster.

In captivity, crows learn to mimic the human voice, as Chamberlain noted in eight tame crows studied. One adult male crow in western Virginia, could say "oh my God, oh Lord" very clearly. An adult male crow in western New York could say "hello" loudly and clearly. One in Florida announced "I'm Jim Crow." The myth regarding splitting a crow's tongue before it will "talk" is probably attributable to the natural split at the tip of the tongue.

One of the functions of mimicry may be to establish and strengthen the individual pair bond (Thorpe and North, 1965). This is particularly so in those species where territorial aggressiveness is not very marked, as the Common Crow (Good, 1952). In certain species, this ability enables each bird to learn the vocal contribution of its mate as well as its own (Thorpe and North, 1965). Crows may use this trait in maintaining contact with a mate. If so, the extreme of this unusual imitative ability of birds in parrots (*Psittacidae*), Starlings (*Sturnus vulgaris*), and crows is plausibly explained. Perhaps Common Crows in the wild use these powers to imitate the idiosyncrasies and inflections in the vocalizations of their mates, or other members of a flock.

Interspecific response to distress calls.—Common Crows were tested by distress calls of the Starling, Bluejay (*Cyanocitta cristata*), and the Common Grackle (*Quiscalus quiscula*). They gathered to the Bluejay calls in 5 of 10 tests, showed no response to the Common Grackle calls in 5 of 6 tests, and were unpredictable in response to the Starling calls. Fish Crows responded positively in all tests of the Starling call.

ACKNOWLEDGMENTS

Release 68-1 of the Virginia Cooperative Wildlife Research Unit, Virginia Commission of Game and Inland Fisheries, Virginia Polytechnic Institute, Wildlife Management Institute, and U. S. Fish and Wildlife Service, cooperating. This investigation was financed by the Frank M. Chapman Memorial Fund and The Virginia Commission of Game and Inland Fisheries. The authors thank S. A. Cable for technical assistance and equipment maintenance and for permitting use of the electronic equipment in the V.P.I. Radio and Motion Picture Studio. Appreciation goes to Lee Wilkins of Deerfield, Virginia, for encouragement, maintenance of electronic equipment, and helpful technical advice. We especially thank Peter Paul Kellogg, Miss L. V. Engelhard, and the staff of the Library of Natural Sounds, Cornell University for the use of the Missilyzer and other electronic equipment. We are most grateful to Mrs. Sadie Wolvin and to the others who let us record the vocalizations of their tame crows. We thank the staff of the Myakka River State Park, Florida for allowing us to record crows on the premises. We are indebted to Mrs. Anne Tatlow IV, Gary Sale, Robert Oster, Gary Howard, Glenn R. Dudderar and the V.P.I. Graduate students who aided in the field testing of crow calls during this study.

SUMMARY

This study documents 23 of the vocalizations of the Common Crow, and describes the appropriate environmental and behavioral context for each. Ten calls were tested in the field to further substantiate and define predicted crow responses to these signals. Crows responded to nine of these field-tested calls. Crow vocalizations described are: assembly call, simple scolding call, modified scolding call, alert call, dispersal call, squalling call, moribund call, threat call, immature hunger and feeding calls, contact call, announcement call, duet notes, juvenile notes, contentment notes, rattling notes, wow-wow notes, carr-carr notes, whisper notes, coo notes, organ notes, wah-oo notes, *C. b. pascuus* screams, and mimicry. Crow responses to interspecific distress calls are noted. These vocalizations are not all the sounds of the Common Crow known to the authors or other workers. The vocal repertoire of Common Crows shows considerable diversification and specialization in relation to behavior patterns concerned with flocking and with predators.

An investigation to determine which sounds are innate, learned, or combinations of both should follow the complete documentation of Common Crow vocalizations. Indeed, the study of sound variation in passerine

populations is important for the analysis of developmental, genetic, and comparative aspects of vocalization as a biological phenomenon.

LITERATURE CITED

- ALLEN, F. H. 1919. The aesthetic sense in birds as illustrated by the crow. *Auk*, 36: 112-113.
- BENT, A. C. 1946. Life histories of North American crows, jays and titmice. U. S. Natl. Mus., Bull. 191: 227-229, 247-249, 262.
- CHAMBERLAIN, D. R. 1967. The vocalizations and syringeal anatomy of the Common Crow, *Corvus brachyrhynchos*. Published M.S. Thesis. Blacksburg, Virginia, Virginia Polytechnic Inst. (Available from University Microfilms, Inc., Ann Arbor, Michigan.)
- CHAMBERLAIN, D. R., W. B. GROSS, G. W. CORNWELL, AND H. S. MOSBY. 1968. Syringeal anatomy in the Common Crow. *Auk*, 85: 244-252.
- COLLIAS, N. E. 1960. An ecological and functional classification of animal sounds. Pp. 368-391 in *Animal sounds and communications* (W. E. Lanyon and W. N. Tavolga, Eds.). Washington, D. C., Amer. Inst. Biol. Sci.
- COLLIAS, N. E., AND M. JOOS. 1953. The spectrographic analysis of sound signals of the Domestic Fowl. *Behavior*, 5: 176-188.
- DAVIS, L. I. 1958. Acoustic evidence of relationship in North American crows. *Wilson Bull.*, 70: 151-167.
- FORBUSH, E. H. 1927. *Birds of Massachusetts and other New England states*. vol. 2. Norwood, Massachusetts Dept. Agr.
- FRINGS, H., AND M. FRINGS. 1957. Recorded calls of the eastern crow as attractants and repellents. *J. Wildl. Mgmt.*, 21: 91.
- FRINGS, H., AND M. FRINGS. 1964. *Animal communication*. New York, Blaisdel Publ. Co.
- FRINGS, H., M. FRINGS, J. JUMBER, R.-G. BUSNEL, J. GIBAN, AND P. GRAMET. 1958. Reactions of American and French species of *Corvus* and *Larus* to recorded communication signals tested reciprocally. *Ecology*, 39: 126-131.
- GOOD, E. E. 1952. The life history of the American crow—*Corvus brachyrhynchos* Brehm. Unpublished Ph.D. Dissertation, Columbus, Ohio State Univ.
- HINDE, R. A. 1969. *Bird vocalizations*. New York, Cambridge Univ. Press.
- HOFFMAN, R. 1904. *A guide to the birds of New England and eastern New York*. Cambridge, Massachusetts, Riverside Press.
- JOHNSTON, D. W. 1961. *The biosystematics of American crows*. Seattle, Univ. Washington Press.
- KNIGHT, O. W. 1908. *The birds of Maine*. Bangor, Maine, C. H. Glass Co.
- MARSHALL, J. 1964. Voice in communication and relationships among Brown Towhees. *Condor*, 66: 345-356.
- MORTIMER, D. 1890. Notes on habits of a few birds of Orange County, Florida. *Auk*, 7: 337-343.
- MUIR, R. C. 1954. Calling and feeding rates of fledged Tawny Owls. *Bird Study*, 1: 111-117.
- ODUM, E. P. 1942. Annual cycle of the Black-capped Chickadee. *Auk*, 59: 499-535.
- THOMPSON, N. S. 1969. Caws and affect in the communication of Common Crows. *Bull. Ecol. Soc. Amer.*, 50: 142.
- THORPE, W. H., AND M. E. W. NORTH. 1965. The lonely tunesmiths of nature-men and the birds. *Saturday Rev.*, 68: 85-87.

- TOWNSEND, C. W. 1923. The voice and courtship of the crow. Bull. Essex County Ornithol. Club, 5: 4-8.
- TOWNSEND, C. W. 1927. Notes on the courtship of the Lesser Scaup, Everglade Kite, crow, and Boat-tailed and Great-tailed Grackles. Auk, 44: 549-554.
- WRIGHT, H. W. 1912. Morning awakening and even-song. Auk, 29: 307-327.

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