

VOCALIZATIONS OF COMMON RAVENS IN VIRGINIA

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ABSTRACT.—I tape recorded 1,210 vocalizations and observed the behavior of Common Ravens (*Corvus corax*) in southwestern Virginia from 1972 through 1976. Eighteen call types were identified and observed in conjunction with behavior at a communal roost, a landfill, and nest sites. I speculate that different call types were associated with excitement, agonistic interactions, aggression, alert, courtship, submission, and thwarting. Common Ravens in Virginia and hand-reared, captive ravens in Germany shared six call types, suggesting that the use of these call types may be innate. Although Common Ravens in Virginia, Alaska, and Germany gave many similar call types, locally learned call types may be present in each geographic area. Numbers of shared call types suggest that vocal behavior of ravens in Virginia resembles that of other North American ravens more than European ravens.

The diversity and complexity of Common Raven (*Corvus corax*) vocal behavior have interested ornithologists and ethologists for years. Although ravens may be locally numerous at food sources, such as dumps (Mylne 1961, Dorn 1972, Brown 1974, Conner et al. 1975), and at communal nocturnal roosts (Cushing 1941, Coombes 1948, Lucid and Conner 1974), their populations are typically of low density, especially during the nesting season (Hooper et al. 1975). Their sparsity in number, coupled with their high intelligence (Bent 1946, Knight and Call 1980, Bruemmer 1984), extreme wariness, and frequently inaccessible nest sites, make it difficult to record their vocalizations within social context. Gwinner (1964) attempted to overcome these obstacles by studying hand-reared, captive ravens, but normal behavior and related vocalizations could have been altered by captivity.

Studies in North America by Dorn (1972) and Brown (1974) included some aspects of Common Raven vocal behavior. Dorn recorded and made audiospectrograms of several different vocalizations, but he was unable to detect distinct behavioral associations with them. Brown (1974) recorded and made audiospectrograms on about 25 different vocalizations and described, in detail and when possible, display postures associated with many of the calls and their behavioral context.

The Common Raven population in the central Appalachians is disjunct from the rest of the population in Canada and the United States (AOU 1983). Thus, vocal behavior of Common Ravens in Virginia may differ from other North American populations as well as from those in Europe. I sought to document the vocalizations and their social context in these birds, and compare my observations with those of comparable studies in North America and

Europe. I was particularly interested to see how Gwinner's (1964) findings on hand-reared, captive ravens applied to wild ravens. Such comparisons may provide insight on determining which aspects of raven vocal behavior are innate and which are learned.

STUDY AREA

My study area (2,500 km²) was located in portions of Botetourt, Craig, Giles, Montgomery, Roanoke, and Rockbridge counties of southwestern Virginia. This area is in the Appalachian Oak Forest plant association of the Eastern Deciduous Forest Province (Bailey 1978) and the Ridge and Valley Physiographic Region (Fenneman 1938), where elevations range from 460 to 1,360 m above sea level. Vegetation in most of the study area is oak (*Quercus* spp.)-hickory (*Carya* spp.) forest, with occasional pine (*Pinus* spp.) stands scattered over the entire area on portions of north-facing slopes. The study area included a nocturnal, communal roost of ravens in Giles County at an elevation of 1,350 m, where yellow birch (*Betula alleghaniensis*) and eastern hemlock (*Tsuga canadensis*) were the dominant cover species (Lucid and Conner 1974).

METHODS

I studied raven vocal behavior from January, 1972, through May, 1976. I recorded most data within 1 h of dusk during late fall and winter, 1973, from the concealment of a blind 30 m from the base of the communal roost. During March through May, 1972 to 1975, I observed raven behavior and recorded vocalizations at six different nests that were within an area 100 km to the northeast and 35 km to the east of the communal roost. Additional observations and recordings were made from a blind at a sanitary landfill that was 15 km southeast of

TABLE 1. Means and standard deviations of variables measured on eight calls vocalized by Common Ravens in southwestern Virginia.

Call type	# recorded	Highest freq. (Hz)	Lowest freq. (Hz)	Call duration(s)	Harmonics #
<i>Caw</i>	358	1,840 ± 19	245 ± 3	0.223 ± 0.003	1.91 ± 0.04
Growl-like	292	1,830 ± 20	240 ± 3	0.278 ± 0.005	—
Whine	337	1,660 ± 23	280 ± 4	0.240 ± 0.007	2.84 ± 0.05
Rattle	10	1,430 ± 88	600 ± 112	0.680 ± 0.067	—
<i>Cawhup</i>	8	1,690 ± 111	220 ± 20	0.248 ± 0.018	1.63 ± 0.26
Staccato <i>caw</i>	5	1,450 ± 25	240 ± 5	0.120 ± 0.003	1.89 ± 0.03
<i>Awk</i>	35	1,660 ± 70	260 ± 16	0.232 ± 0.014	1.40 ± 0.18
<i>Cluck</i>	109	1,810 ± 30	550 ± 36	0.087 ± 0.004	1.01 ± 0.11
<i>Kow</i>	1	7,000	950	0.270	7
Bell-like	8	1,020 ± 152	360 ± 76	0.365 ± 0.099	0.25 ± 0.31
<i>Ku-uk-kuk</i>	1	4,000	600	0.680	—
<i>Ko-pick</i>	10	1,075 ± 20	600 ± 20	0.187 ± 0.008	—
<i>Ank-up</i>	8	1,440 ± 41	630 ± 150	0.271 ± 0.035	0.25 ± 0.16
<i>Woo-oo-woo</i>	1	1,000	400	0.510	1
Uvular	2	1,000	900	0.110	—
<i>O-ot</i>	1	1,700	550	0.250	1
<i>Puddle</i>	4	1,200	550	0.170	1
<i>Ke-aw</i>	20	1,780 ± 64	255 ± 6	0.226 ± 0.004	1.15 ± 0.08

the roost. Whenever possible, I made observations and recordings of ravens soaring above the many mountain ridges in the study area. Many of the foregoing observations on bird behavior were made without tape recording concurrent vocalizations, as well as the reverse.

When watching pairs of ravens at nest sites, I always assumed the larger bird to be the male (Willett 1941, Coombs 1978). I usually could not determine the sex of ravens at the roost because of their number and movement. I did not attempt to distinguish between females and non-breeding young ravens because of their morphological similarity.

I used a 1-m diameter parabolic reflector and Uher 4000 report-IC or Panasonic RQ-2035 tape recorders at a tape speed of 9 cm/s to record vocalizations. Sonagrams were produced with a Sona-graph 7029-A on the wide band setting of the linear frequency scale. All sonagrams were made using the 40–4,000 Hz range. To quantify calls, I measured the highest and lowest frequency (Hz), the length (s), and the number of harmonics above the fundamental frequency of each call (Table 1). I classified the sounds into various call types based on their sonographic appearance and on my ability to distinguish them in the field.

RESULTS

I tape-recorded 1,210 Common Raven vocalizations (18 call types) and made concurrent behavioral observations on 972: 521 observations at the communal roost, 222 on mountain ridges throughout the study area, 180 at nest sites, and 49 at the landfill. The social context of some call types was discernable because they were elicited by particular stimuli.

Ravens gave other call types in more than one context. Call types with simultaneous behavioral observations are described in order of decreasing frequency of occurrence. My observations on behavior only report occasions when I also heard a call. They do not include instances when particular behaviors were observed without vocalizations. Thus, the numbers document my findings, but have little comparative value.

THE *CAW* (FIG. 1a)

The *caw* was a loud, hoarse sound, given singly or repeated many times. The raven's *caw* sounded similar to that of the American Crow (*Corvus brachyrhynchos*), but was much lower in pitch. It varied in pitch and duration, perhaps in relation to the age and sex of the bird or the intensity of the stimulus eliciting the call. Some *caws* audibly ascended in pitch while others descended. I tape-recorded 358 of the 536 *caws* I heard (Table 2).

Context—1. *Caws* were the most common vocalizations of single ravens and small flocks of ravens that were observed soaring above mountain ridges (189 instances), flying above or perched in the communal roost (146 occasions), or flying above a sanitary landfill, apparently trying to see if the area was safe to land and begin foraging in the garbage (35 instances).

Context—2. *Caws* were the most frequent call when I disturbed ravens at nest sites (72 observations). When young were in the nest, *caws* given by a single raven usually caused the bird's mate to return to aid in defense of the nest. On one occasion, I noted that the *caw* of the presumed female of the pair was slightly higher-pitched than that of the male.

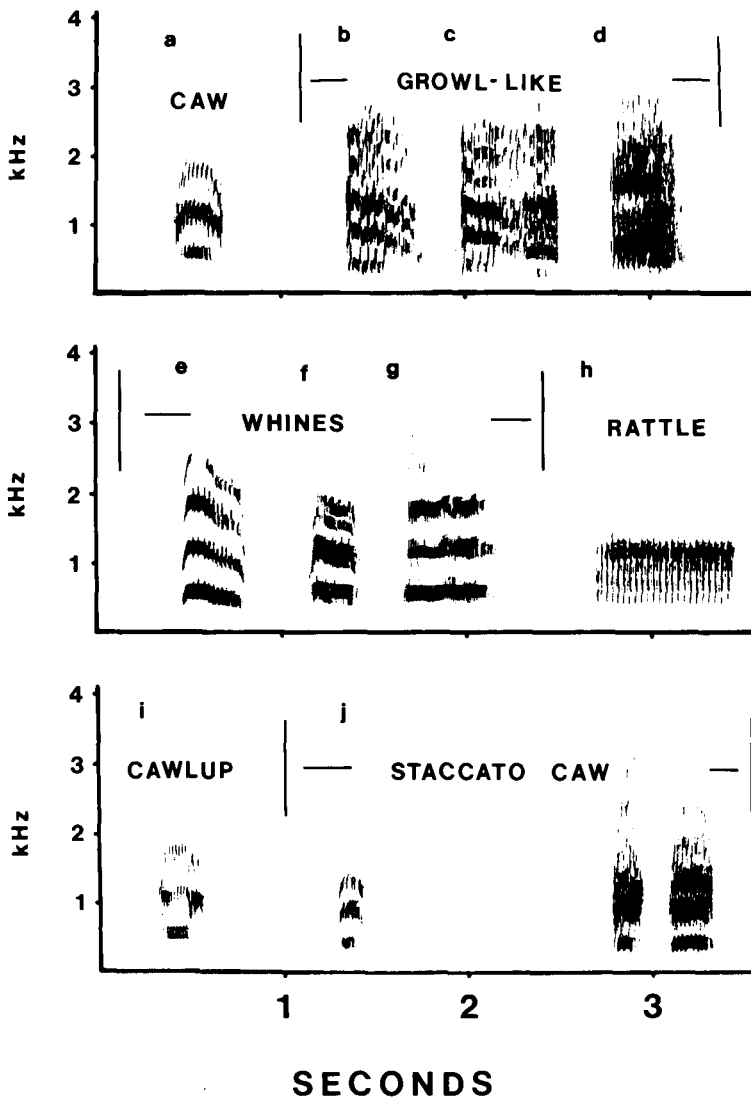


FIGURE 1. Vocalizations given by Common Ravens in Virginia: a—the *caw*; b, c, and d—growl-like sounds; e, f, and g—whines; h—the rattle; i—the *cawlup*; and j—staccato *caw*.

Context—3. On four occasions, several ravens, possibly immatures, gave *caws* while “playing” and pursuing each other above the roost for the possession of a twig or similar, apparently useless, object.

Context—4. “Spectator” ravens gave *caws* while they watched agonistic activities of other ravens near them (90 instances). Although no feathers were displayed with this vocalization, unspread wings were slightly raised and the raven’s head usually bobbed noticeably while the call was given in this context.

GROWL-LIKE SOUNDS (FIGS. 1b, c, and d)

These sounds were loud and harsh; they had a pulsing, growl-like quality. Although I recorded 292 growl-like sounds, I saw concurrent behavior on only 97 occasions.

Context—1. I heard these sounds at the roost as the ravens were finding positions in trees to spend the night. In each instance, one or both of two ravens trying to get the same roost position gave growl-like sounds. I could not see clearly which was the aggressor.

WHINES (FIGS. 1e, f, and g)

Whines were soft calls and sounded much like the mono-pitched, or on occasion, the multi-harmonic whine of a dog. I made behavioral observations on 51 of the 337 calls I recorded.

Context—1. I heard this call only at the roost in what appeared to be agonistic confrontations over position in the roost trees. Individuals giving the call appeared to retreat from an apparently dominant raven.

TABLE 2. Summary of Common Raven call types and their behavioral context.

Call type	Figure number	Number of calls with behavioral contexts	Behavioral contexts
<i>Caw</i>	1a	536	Conflict, aggression, excitement, alert, play, unknown
Growl-like	1b, c, d	97	Aggression
Whine	1e, f, g	51	Conflict, submission
Rattle	1h	49	Courtship, associated with pairs
<i>Cawlup</i>	1i	38	Unknown, possibly a location call
Staccato <i>caw</i>	1j	35	Alert
<i>Awk</i>	2a	30	Unknown
<i>Cluck</i>	2b	29	Distress, thwarting
<i>Kow</i>	2c	27	Aggression, attack call
Bell-like	2d, e	27	Courtship, associated with pairs
<i>Ku-uk-kuk</i>	2f	18	Aggression, chasing another raven
<i>Ko-pick</i>	2g	16	Pair associated, unknown
<i>Ank-up</i>	2h	6	Pair associated, unknown
<i>Woo-oo-woo</i>	2i	0	Unknown
Uvular	2j	2	Unknown
<i>O-ot</i>	2k	1	Unknown
<i>Puddle</i>	2l	4	Unknown
<i>Ke-aw</i>	2m	4	Unknown

THE RATTLE (FIG. 1h)

Rattle calls resembled the territorial drumming of Downy Woodpeckers (*Picoides pubescens*), but were about twice as loud. I recorded 10 of the 49 rattle calls I heard.

Context—1. Ravens gave rattle calls during courtship (49 occasions) at the roost, the sanitary landfill, and nest sites. During the rattle call, ravens arched their neck and pointed their bill downward with the tip spread about 7 to 8 cm in a gaping, or choking, action. Typically, leg and throat feathers and all the head feathers were ruffled and displayed during this vocalization. I heard the rattle call throughout the year, but most frequently during the breeding season. The bell sound (Figs. 2d and e) was often given in conjunction with the rattle.

THE CAWLUP (FIG. 1i)

The *cawlup* call was moderately loud and I could hear it at distances of several kilometers if the raven was soaring above a mountain ridge. This call resembled the *caw* (Fig. 1a), but had a two-syllable sound. I was able to record only 8 of the 38 *cawlups* I heard while watching individuals.

Context—1. I heard this call during aerial courtship on 15 occasions. On four occasions, the caller's mate replied with the *ank-up* call (Fig. 2h).

Context—2. Single ravens gave *cawlups* as they soared above mountain ridges (12 cases), or while flying above the roost (11 cases). The call was usually repeated two or more times.

STACCATO CAWS (FIG. 1j)

This call resembles the *caw* (Fig. 1a), but is about one-half as long in duration (Table 1).

Figure 1j represents a typical staccato *caw* (0.25 s) followed (1.3 s) by two longer *caws*. Variations on this basic call either increased the number of *caws* following the initial sharp *caw* or totally eliminated them. I recorded 5 of the 35 staccato *caws* I heard.

Context—1. These calls were the first to be given on nine of 39 occasions when I disturbed pairs at their nests. Ravens gave staccato *caws* on 15 of 24 occasions when flushed from the roost. Figure 1j shows the call given by a raven when a Golden Eagle (*Aquila chrysaetos*) dived at the roost just before nightfall and flushed the ravens. Ravens gave staccato *caws* at the sanitary landfill on 11 of 32 occasions when they were flushed by dogs, humans, or trucks.

THE AWK (FIG. 2a)

This call was harsh and low in frequency. Of 35 *awks* recorded, I observed concurrent behavior for only 30.

Context—1. On 28 separate occasions, the *awk* call was given singly by ravens in roost trees. I did not detect any response from other ravens.

Context—2. On two occasions, the *awk* call was uttered by one raven while chasing another. The call was repeated twice in both of these instances.

THE CLUCK (FIG. 2b)

Typically, ravens gave a series of staccato *clucks* in couplets (Fig. 2b). Occasionally, four to nine *clucks* were given in rapid succession. Each *cluck* had a sputter-like quality. I observed the behavior associated with 29 of the 109 *clucks* recorded.

Context—1. I heard *clucks* on 17 occasions

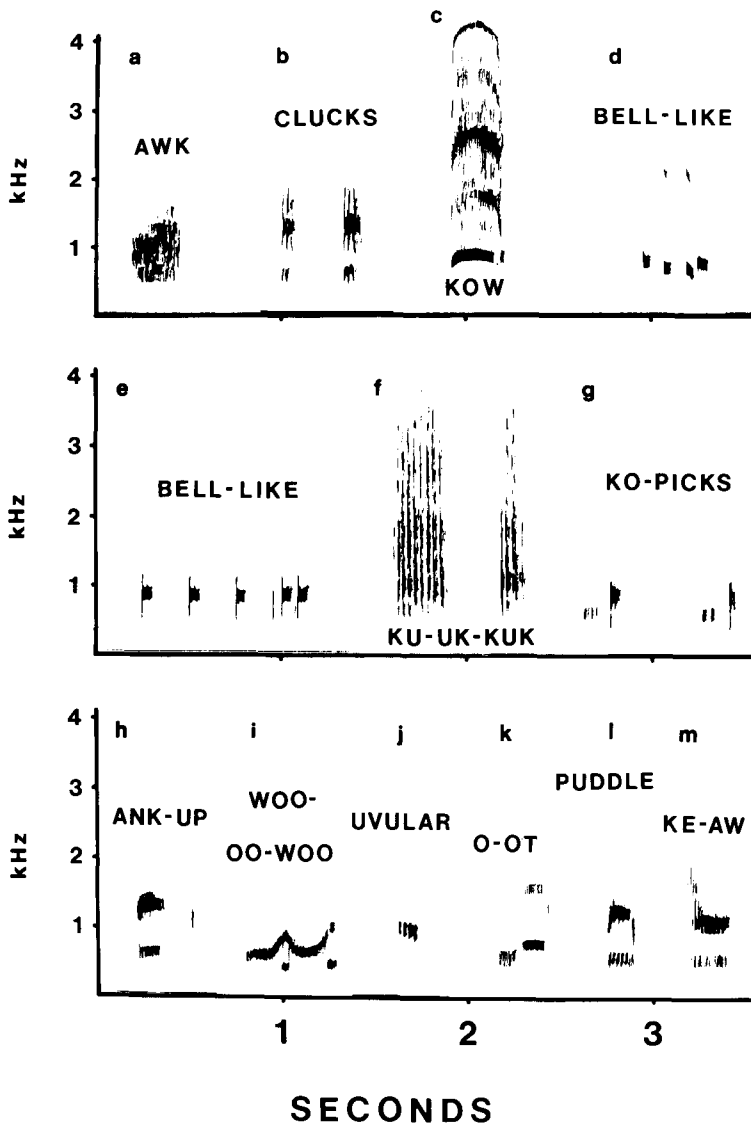


FIGURE 2. Vocalizations given by Common Ravens in Virginia: a—the *awk*; b—*clucks*; c—the *kow*; d and e—bell-like sounds; f—the *ku-uk-kuk*; g—the *ko-pick*; h—the *ank-up*; i—the *woo-oo-woo*; j—descending uvular sound; k—the *o-ot*; l—the *puddle*; m—the *ke-aw*.

when nesting pairs were disturbed at their nests. The *clucks* were usually given by flying or perching birds after some time had elapsed (10–15 min.) during my nest visits.

Context—2. On 12 occasions, ravens gave *clucks* when displaced from what appeared to be a favored roost position.

THE *KOW* (FIG. 2c)

The *kow*, which resembled the high pitched *honk* of a Canada Goose (*Branta canadensis*), was the loudest call I heard. The call has many harmonics, which range up to 7,000 Hz. Although I observed ravens give the call 23 times, I tape-recorded it only once.

Context—1. I heard this call 18 times at nests

when examining young, and an adult dived at me, flew over me, or perched in a tree nearby.

Context—2. The male raven of a nesting pair gave the call once when attacking a strange raven that flew within 50 m of its cliff nest (five cases). The call was given immediately before the male raven's physical contact with the intruder. Ravens also gave *kows* as they chased other ravens out of the roost (three cases).

Context—3. I heard the *kow* during an agonistic encounter between two male ravens. Pairs A and B were standing to the side of a landfill trench when pair B walked over to within 2 m of pair A. The two males were the closest birds, with the females positioned about 0.5 m behind their mates. All four ravens dis-

played tufts of feathers on either side of the tops of their heads as well as their throat and leg feathers. The pairs faced each other silently for about 1 min, after which pair B flew into the trench and began to feed. Pair A then began courtship activities, after which male A flew into the trench, displayed his throat, leg, and all his head feathers, and walked toward male B. Male B then displayed the same feathers and hopped toward male A. Both ravens faced each other for 10 s with their heads held high and bills pointed slightly downward. Both males began hopping off the ground slightly, as if to gain an advantage over each other. The apparently more dominant male A then attacked male B, jumped up in the air 1.5 m, gave a *kow*, and landed on male B. Male A tried to clutch male B with its feet while beating with its wings and thrusting with its bill. Male B broke loose and rapidly flew off unpursued by male A. Female B followed male B as he flew off.

THE BELL-LIKE SOUND (FIGS. 2d and e)

This call was not loud, but I could hear it from a distance of more than 1 km under good conditions. The sound resembled that emitted by a bell or xylophone that had been struck while being held to prevent continued ringing. Ravens also gave the call softly so that it resembled soft *hoots* of a Great Horned Owl (*Bubo virginianus*). I recorded 10 of the 27 calls I heard.

Context—1. Male and female ravens gave bell-like sounds during aerial courtship (20 instances) and courtship on the ground and in trees (six cases). Perched ravens displayed all head, throat, and leg feathers in addition to spreading their rectrices when giving the call. Bell-like sounds were heard most frequently during the breeding season.

Context—2. I heard the call during what appeared to be an agonistic interaction between two male ravens. Both males had all head, throat, breast, and leg feathers displayed and gave the bell call before strutting parallel to each other.

THE KU-UK-KUK (FIG. 2f)

The *ku-uk-kuk* call was a harsh, staccato couplet or triplet with frequencies ranging between 600 and 4,000 Hz. It resembled the *cluck* (Fig. 2b) slightly and also had a sputter-like quality. I recorded only one of the 18 calls I heard.

Context—1. The *ku-uk-kuk* call was given by a raven as it chased another raven at the roost (18 occasions). Usually, the pursuing raven was as close as 2 m to the pursued raven when giving the call.

THE KO-PICK (FIG. 2g)

The *ko-pick* resembled the sound of a coffee percolator; however, its tonal quality was similar to the bell-like sounds (Fig. 2d, e). Ravens always gave the *ko-pick* twice in succession (Fig. 2g). Two frequencies (700 and 1,100 Hz) occasionally composed the first element of each call.

Context—1. I heard the *ko-pick* 16 times. Paired ravens gave this call while flying (12 occasions) and while perched in the roost (four cases). I noted no particular behavior associated with the call.

THE ANK-UP (FIG. 2h)

The *ank-up* resembled the squeaking of an old fashioned pump handle. The call was similar to the Blue Jay's (*Cyanocitta cristata*) *pump handle* or *squeaky gate* call (Cohen 1977), but was much lower in pitch. Ravens usually repeated the call twice. I made concurrent behavioral observations on all of the eight calls recorded.

Context—1. One of a pair of flying ravens (three different pairs) gave this call at nest sites (eight occasions). On two occasions, its mate responded with the *cawlap* call (Fig. 1i). In four instances, a raven gave the *ank-up* call in response to a *cawlap* call from its mate.

INFREQUENT VOCALIZATIONS (FIG. 2i, j, k, l, and m)

I heard many vocalizations only once or rarely. I was able to record some of them to document their existence and illustrate the variety of raven vocal behavior. An unseen raven gave a soft *woo-oo-woo* at the roost (Fig. 2i). A single pair of ravens gave the following calls while flying when I disturbed them at their nest: a descending uvular sound (Fig. 2j), a call sounding like *o-ot* (Fig. 2k), and a call sounding much like *puddle, puddle, puddle, puddle* (Fig. 2l). A rattle (Fig. 1h) was the response when one of the pair gave a *ke-aw* (Fig. 2m) call four times.

DISCUSSION

Goodwin (1976) described Common Ravens as "very loquacious." Common Ravens in Virginia fit this characterization and regularly gave a variety of calls. Fundamental frequencies of most calls ranged from 250 to 2,300 Hz (Table 1, Brown 1974), which are well suited for long distance communication (Wiley and Richards 1982). I recorded sufficient numbers and social contexts of some calls to permit speculation on their social interpretation (Table 2). Many of these calls are used by ravens in similar contexts in other areas of their range.

The *caw* (Fig. 1a) was used in a variety of

contexts and seemed to convey general excitement, whether the stimulus was from a potential predator, daily activities, "play," or agonistic interactions of other ravens. The *caw* is probably the most frequently described call in other areas around the world. My observations on social context support and expand on what Gwinner (1964), Brown (1974), and others found. Brown (1974) recorded a sonographically similar call in Alaska and thought it to function as a "distress" call. Gothe (*in* Gwinner 1964) and Gwinner (1964) described a *rapp* or *krapp* that was given by flying German ravens in the wild and in captivity. Wilmore (1977) also described a *krok-krok-krok* given by flying ravens. Russian ravens (*C. c. corax*) give a croaking, described as *kruk, kruk, kruk* (Dement'ev et al. 1954). Tyrrell (1945) described a hoarse, guttural, rolling *cr-r-r-r-cruck* that may be the same as the *caw* I heard. Some of the variation (frequency, Hz) in the *caw* may relate to the age and sex of ravens. I noted, as did Harlow (1922), that *caws* of females were higher in pitch than those in males. Much of the within-call variation in frequency, however, may also relate to unidentified social communication.

European and Alaskan ravens also give growl-like calls. These vocalizations of Virginia ravens (Figs. 1b, c, and d) resemble the typical enemy call, "Gewöhnliche Feindruff," and loud enemy call, "Laute Feindruf," recorded by Gwinner (1964). He thought the calls to be a defensive reaction to a predator stimulus. Brown (1974) also heard a sonographically similar call ("antagonistic *Kaaa*") given by subordinate ravens when threatened by more dominant birds in Alaska. Morton (1977, 1982) predicted that sounds used by aggressive birds should be low and relatively constant in frequency (Hz). My observations on growl-like calls, as well as Gwinner's (1964) and Brown's (1974), support Morton's prediction.

Whines (Figs. 1e, f, and g) were also given by ravens in Alaska and Europe. In Virginia, submissive ravens gave whines during conflicts with other ravens. Brown (1974) recorded a sonographically similar call that he thought was given only by young ravens as a defensive call. Gwinner (1964) reported a sonographically similar *ruh* call given by young and adult ravens that he thought served in part as a submissive call. Gwinner also recorded a "Wissellaute" (whine or whimper) that young ravens gave when preened by their parents. Whines may serve as an appeasement sound to avoid further hostile interaction with stronger, more dominant birds. Relative to growl-like calls, whines are higher in frequency (Hz) and tend to decrease in frequency over

time. Morton (1982) suggested that sounds of this structure are used by fearful or appeasing individuals.

European ravens also gave rattle calls (Fig. 1h). Gwinner (1964) described a *gro* call that intimate ravens gave when reunited and during pair feeding in captivity. Coombs (1978) noted that Gwinner's (1964) ravens gave a softer version of the *gro* call, the "Gauzlaute," when mutual preening was done roughly. Emeis (1926) also heard a deep rattle call, followed by a bell-like call, from a wild pair of ravens in Germany. The rattle calls that I heard were given mainly by pairs of ravens during the breeding season and often were associated with bell-like sounds. Brown (1974) did not report rattle calls in Alaska. I suspect that rattle calls serve as a part of courtship and aid in strengthening pair bonds. I observed ravens using a gaping or choking action as they gave the rattle call. This posture may be necessary to produce the mechanical clicks that compose the rattle. Lorenz (1940), however, also observed a choking action, but with what may be a different call: *Krrooa* (Goodwin 1976).

Only North American ravens have been reported to give the *cawlop* call (Fig. 1i). Brown (1974) described a sonographically similar call as *Kowah*, but could attach little behavioral significance to it. Although Griffin and McCallum (1951) heard a *tch-reep* when one pair of ravens attacked another pair in England, I doubt that they heard the call I described as *cawlop*. I never heard the *cawlop* given during aggression or attacks in Virginia. Gwinner (1964) did not hear a similar call from captive German ravens. I have no direct evidence on the social function of the *cawlop* call, but speculate that it serves to convey location.

The use of staccato *caws* (Fig. 1j) by ravens in alert situations has previously been described in North America (Tyrrell 1945, Dorn 1972, Brown 1974, Conner et al. 1975). Gwinner's ravens in Germany may not have given staccato *caws* because of the restraints of captivity. Emeis (1926), however, heard frightened, wild ravens give a short, loud *rab* or *ra*. I played staccato *caws* (Fig. 1j) back to ravens on three occasions at nest sites. On each occasion, the birds became excited and flew around, scanning the ground and sky.

Clucking (Fig. 2b) may have indicated distress or thwarting because ravens gave the call when they were unable to drive me away from a nest. Dorn (1972) also recorded a *cluck* call, but attached no social significance to it. Although Gwinner (1964) heard "glucken" (clucking) from captive ravens, his sonagram of the call resembles that of the bell-like call (Fig. 2e) in frequency (Hz) and structure.

The *kow* (Fig. 2c) served as an aggressive call and, in many instances, as an actual attack call in North America and Germany. When teased, a captive raven in Virginia also gave the *kow* while in its cage (Dwight R. Chamberlain, pers. comm.). Gwinner's (1964) captive ravens gave a *krack* that is probably the same as the *kow* when attacking and during intense conflict. Wilmore (1977) mentioned a *konk* given by ravens (location not mentioned) during aggression with predators. In Wyoming, Dorn (1972) recorded a high pitch *ky* that appears similar to the *kow*, but made no mention of its social context. Brown (1974) also recorded a sonographically similar "juvenile *Kaah*" in Alaska, but it was not an adult call. The calls I heard were given by what always seemed to be adult birds. Dement'ev et al. (1954) reported a *kaarr, kaarr* . . . emitted by desert ravens (*C. corax ruficollis*) when attacking, but this call was probably a *caw* (Fig. 1a).

Ravens in North America and Europe give bell-like sounds (Fig. 2d and e) mostly during courtship. I suspect that these calls serve to strengthen pair bonds and, perhaps, help synchronize partners in the nesting cycle. Gwinner (1964) heard a captive female give a bell-like call as a response to a male during a bowing ceremony. He believed the call to be an imitation of a bell. Ross (1925) and Brown (1974) heard a call that sounded like a xylophone. Brown observed females give the call from a slightly crouched submissive posture in the presence of a courting male and during strutting ceremonies as the female followed a strutting male around. On one occasion, the call was given just before an unsuccessful attempt at mounting. Gilbert (1927) described the call in England as "a triple *toc-toc-toc*" and thought it could be an "invitation note." Emeis (1926) heard a bell-like call from wild ravens in Germany that he described as a *kjou, khou*. Gothe (in Gwinner 1964) heard a *klong, djong* or *kronk* given during aerial courtship. Common Ravens in Tibet also gave bell-like sounds (Wilmore 1977). The bell-like call may serve a different function when given among males, because both Gwinner (1964) and I heard the call during what appeared to be agonistic behavior between males.

The *ku-uk-kuk* call (Fig. 2f) resembled the *cluck* (Fig. 2b), but was used as a threat during aerial chases. Brown (1974) described a *Kukuk* given by ravens under analogous circumstances in Alaska. Gwinner (1964) did not report such a call from ravens in Germany, possibly because of the limited ability of his captive ravens to chase either each other or intruding strange ravens.

Ko-pick calls (Fig. 2g) have previously been

described in North America. Harlow (1922) mentioned a rare call that sounded like *ge-lick-ge-lee*. Brown (1974) described a *Kul pick* or *Ko puck* that he thought to be a variation of the bell-like call (Figs. 2d and e). He thought the last part of the call was produced by a bill snap. This was not the case in the calls I recorded. Jollie (1976) heard *t'Puck* calls from North American ravens during their "greeting and intimidation" displays. He noted that Lorenz (1940) and Gwinner (1964) did not describe this call. Although the *ko-pick* was a pair-associated call, Brown (1974) and I could not identify its specific social function.

I could not discern the social significance of the remaining seven calls (Fig. 2a, h, i, j, k, l, and m), two of which are widely used by ravens. Brown (1974) recorded a call similar to the *puddle* call (Fig. 2l); he, too, could not discern a social function. Emeis (1926) heard a *kyou, kyou* that closely resembles the *ke-aw* (Fig. 2m). He also heard a "rattle" in conjunction with the call from a pair of wild ravens.

Most corvids, excepting the Jackdaw (*Corvus monedula*) and Cuban Crow (*C. nasicus*), may have a somewhat similar repertoire of calls (Jollie 1976). Several North American corvids have calls that resemble those of Common Ravens. White-necked Ravens (*C. albi-collis*) give *Kre* and "growling" sounds that are similar in sound and function to the Common Raven's *caw* and growl-like sounds, respectively (Jollie 1976). The similarity of these calls reflects the close affinity of the two species (Goodwin 1976). Although higher in pitch, the American Crow's "scolding" and "dispersal calls" (Chamberlain and Cornwell 1971, Jollie 1976) are similar in sound and function to Common Raven *caws* and staccato *caws*, respectively. American Crows give a raucous "assembly call" when near predators; the call apparently serves to assemble a group of crows to drive predators away from nesting, roosting, or feeding areas (Chamberlain and Cornwell 1971). Although mobbing by non-breeding flocks of ravens occurred, I never detected a specific assembly call.

Although much higher in pitch, the Blue Jay's *jay* call resembles Common Raven *caws* and is also given during excitement (Cohen 1977). Like ravens, these jays also give a "rattle" and a "bell call," mainly during the breeding season (Cohen 1977). The Blue Jay's "squeaky gate" call given during the prenesting season (Cohen 1977) resembles the Common Raven's *ank-up* call. Florida Scrub Jays (*Aphelocoma coerulescens*) give a mechanical, clicking sound that may also resemble Common Raven rattles (Woolfenden and Fitzpatrick 1984).

Imitation of other species and non-animate

sounds is widespread in the Corvidae (Goodwin 1976). Gwinner (1964) suspected that some sounds his captive ravens made were imitated. Common Ravens can imitate the *caw* of the American Crow (Jollie 1976). Coombs (1978) noted that ravens modify innate and learned calls and use these sounds to recognize individual ravens. He suggested that a raven can use "its partner's special sounds" to call its mate and cause it to come immediately.

I believe that many of the calls I recorded are innate, based on their similarity to vocalizations of other corvids and Common Ravens elsewhere in the world. Although vocalizations learned in one environment can spread from one individual to another (Slater 1983), transfer of such sounds would be inhibited by isolation. Ravens in Virginia are disjunct from the rest of the North American population and certainly remote from those in Germany. Gwinner's (1964) captives were all hand-reared and almost completely isolated from wild ravens. Thus, identical calls given by Gwinner's birds and ravens in Virginia (*caw*, growl-like, whines, rattle, *kow*, bell-like) are probably innate.

Many other raven calls may be learned and passed on to subsequent generations. Gwinner (1964), Brown (1974), and Dorn (1972) all reported calls that I did not hear in Virginia. Ravens in Virginia, however, had more calls in common with other North American ravens (about 10 calls) than with European ravens (seven calls), suggesting that distance and geographic barriers (water) may influence the exchange of learned calls.

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RECENT PUBLICATIONS

The life and letters of Alexander Wilson.—Edited by Clark Hunter. 1983. American Philosophical Society, Philadelphia. 456 p. \$50.00. Alexander Wilson was born in Scotland in 1766 and spent his early adult years there as a weaver, peddler, reformer, and poet. He came to the United States in 1794 and turned to school teaching, which led to his acquaintance and friendship with the botanist, William Bartram. This association aroused his interest in birds, ultimately his aim to publish the most complete illustrated account of the birds of America that had yet been attempted. The enterprise lasted but ten years, until his death in 1813, but it sufficed to establish Wilson's reputation as the "Father of American Ornithology." The present book offers first a good, relatively brief biography of the man and then 150 of his letters, many of them newly published or published complete for the first time. They contain a wealth of fascinating observations about his travels and the progress of his *Ornithology*. Several additional documents are given in the appendices. The volume itself has been beautifully designed and printed, a rare treat in an era of computerized photo-typesetting. It is illustrated with photographs, maps, wood engravings by Thomas Bewick, and selected reproductions of Wilson's plates—together with Audubon's plates of the same birds. The book adds important new details to our picture of this pioneer ornithologist.

Johann Friedrich von Brandt. *Icones Avium Rossico—Americarum Tabulae VII, Ineditae* with comments on birds, expeditions and people involved.—Bernt Løppenthin. 1984. Scandinavian fine editions, Copenhagen. 70 p. 385 Danish kroner (\$34.75). Source: Scandinavian fine editions, P.O. Box 1019, DK-1007, Copenhagen K, Denmark. Brandt (1802-1879) was a German physician who made his career as director of the zoological museum at the Academy of Sciences in St. Petersburg. Based on specimens collected by others, he published many papers, including a description of the cormorant species which bears his name. He worked on, but never completed, a large work on the birds of the Russian North Pacific possessions, including the Russian territories in America (now Alaska). Apparently made for that opus were seven unique, hand-colored lithographic plates, drawn about 1835 by W. Pape. They are here published for the first time, reproduced from a set in the University Library, Copenhagen. Løppenthin provides valuable background on Russian American settlements and expeditions before 1835, of importance to ornithological studies. He then discusses, for each of the 44 species of birds, the history of its taxonomy and of the specimen depicted. The plates themselves appear to be accurate facsimiles in size, color, and detail. This scholarly, well-produced volume makes a signal contribution to the ornithological history of the North Pacific and Bering Sea. List of references, index, map.