THE FISH CROW (*CORVUS OSSIFRAGUS*) AND ITS MEXICAN RELATIVES: VOCAL CLUES TO EVOLUTIONARY RELATIONSHIPS?

JOHN WILLIAM HARDY
Bioacoustic Laboratory and Archives, Florida Museum of Natural History, University of Florida, Gainesville, Florida 32611

Abstract.—The Fish Crow (*Corvus ossifragus*), ranging from the New England coast of the U.S.A. southward to Florida, along the Gulf of Mexico to central coastal Texas, and inland up certain rivers, the Tamaulipas Crow (*C. imparatus*), native to the eastern lowlands of Mexico, and the Sinaloa Crow (*C. sinaloae*), of the Pacific coast lowlands of Western Mexico, form a superspecies. These forms do not meet in the wild. The species-specific adult calls are remarkably different in each species. I kept Fish Crows and Tamaulipas Crows in an aviary and the latter species bred successfully. I studied the development of voice in young from nestling stage (July-August) to full-grown (January). Fledgling Tamaulipas Crows sound like adult Fish Crows; the voice changes gradually, and by completion of the pre-basic molt, the birds sound like their parents. I believe, as discussed, that the Tamaulipas Crow is derived from the Fish Crow, and that the peculiar, guttural, frog-like sounds of the Tamaulipas Crow are derived. Biochemical studies are needed for further elucidation of North American *Corvus* evolutionary relationships.

From 1985 to 1988, I kept from six to nine Tamaulipas Crows (*Corvus imparatus*) in captivity in a large outdoor aviary, studying their social behavior, nesting, and vocalizations. This crow in maturity has a highly distinctive, guttural, frog-like voice. It is considered conspecific with the Sinaloa Crow, as the Mexican Crow (*C. imparatus*) by the AOU checklist (AOU 1983) and is morphologically almost identical to that western form. I consider them separate species, the Tamaulipas Crow, *C. imparatus*, and the Sinaloa Crow, *C. sinaloae*. A third species, the slightly larger Fish Crow (*C. ossifragus*) is almost certainly a close relative of the two Mexican forms, and, in fact, they were all considered conspecific (as races of *ossifragus*) at one time (Hellmayr 1934). The ranges of these three crows are shown in Fig. 1. Note that there is no geographic contact among the three. My first interest in these birds was excited by the remarkable difference between the voices of the Tamaulipas and Sinaloa forms. This difference, first brought to the attention of ornithologists by Davis (1958) caused him to recommend that they be considered separate species. The Fish Crow's voice also is distinctive, and, as crows go, these three, almost certainly each others' closest relatives and forming a superspecies, could hardly have more easily distinguishable vocalizations. The difference in structure of the sounds is shown in Fig. 2.

Florida Field Naturalist 18(4): 74-80, 1990.

My first research plan was to attempt hybridization and cross-fostering of these three crows in the aviary, which proved, for me, impossible.

In the course of my work, Tamaulipas Crows did nest successfully on two occasions in the aviary (1985, 1987) and on two other occasions produced young that did not survive. The three young that survived to adulthood in 1987 are the subject of this paper and they were studied through their first 6 months of ontogenetic development, with special attention given to voice. In an earlier paper dealing with breeding Tamaulipas Crows in captivity (Webber and Hardy 1985), characteristic calls of all three species of crows mentioned above were presented and Fig. 1 f, g, of the 1985 paper showed how a call of a captive juvenile Tamaulipas Crow resembled one call of wild adult Fish Crows. This call was the simple *caw* that has homologues in many *Corvus* species (see, for example, Hardy 1990). By itself this call is rather uncommon in Fish Crows, which are given to such a variety of more complex tonally variable social conversation vocalizations. The simple *caw* is, however, the elemental alarm call of this species. The present paper found its initial stimulus in the resemblance of a call of juvenile Tamaulipas calls to the Fish Crow *caw*.

METHODS

Throughout the nestling periods, the aviaries were visited daily to provide food (high protein dog meal, chopped apples, grapes, sliced oranges, plus live crickets and meal worms

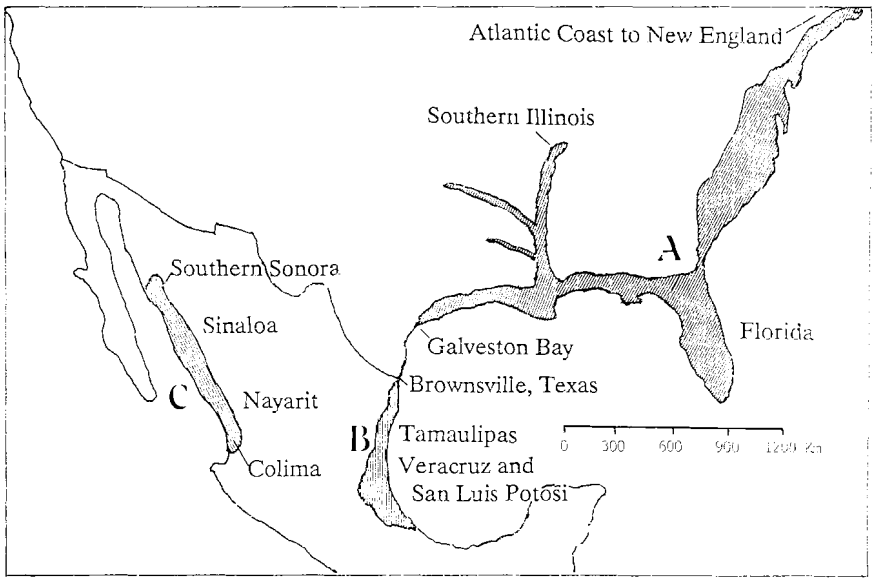

Figure 1. Map showing geographic ranges of A. Fish, B. Tamaulipas, and C. Sinaloa crows.

during the nestling periods). The adults fed the young mostly live food. On these aviary visits, changes in vocalizations from the faintest squeaks of hatchlings to the harsh sounds of fledglings were noted and sometimes tape recorded. After the young were fledged, the aviaries were visited three or four times per week, with tape recording of voice continued when changes were noted.

Recordings were made on a Stellavox SP-7 open reel and a Sony WMD6-C Professional Walkman cassette recorder, using various condenser microphones (such as Sennheiser K3U-ME 80 and Audio-Technica AT-9300 models). The recordings, some illustrated in this paper, were analyzed on a Kay Elemetrics Sona-Graph, model 7029-A, using the wide (300 Hz) band pass filter. The tape recordings referred to in this study were all contained on Master Tape 954 in the Bioacoustic Archives of the Florida Museum of Natural History.

Results

By the time nestling Tamaulipas Crows are almost fully feathered, and ready to leave the nest (25-28 days old), they have strong vocal abilities, although not a varied repertoire. As Fig. 3 shows, their cawing calls are remarkably similar to *caws* of adult Fish Crows. These calls are only faintly guttural, and show moderately clear tonal intervals. The narrow intervals between successive tones suggests that two-voice syringeal source unique to birds (Borror and Reese 1956; Greenewalt 1968). The sound has a falsetto quality (hear the voice of adult Fish

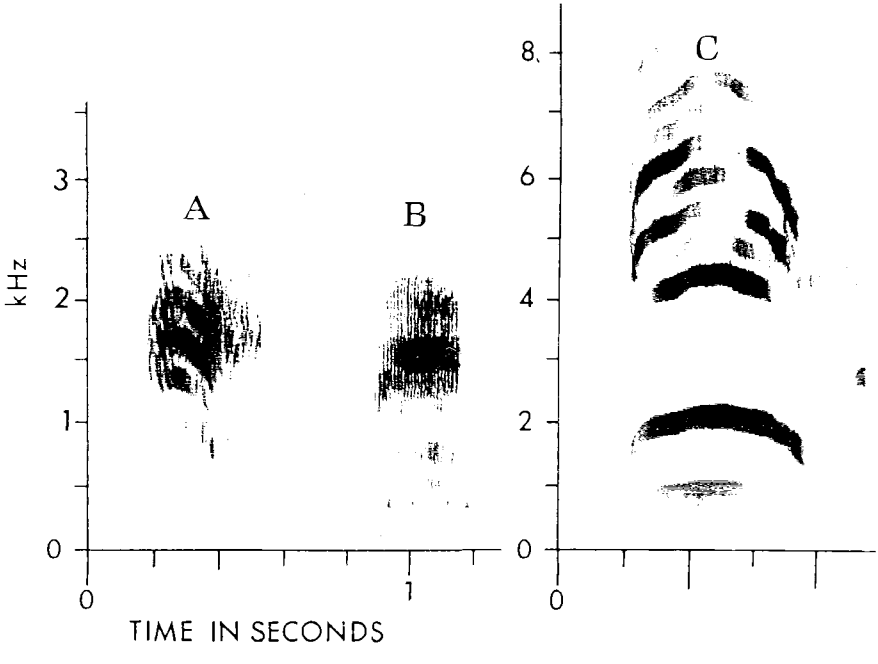

Figure 2. Sonograms of the most characteristic, loud, species-specific vocalizations of: A. Fish Crow; B. Tamaulipas Crow; C. Sinaloa Crow.

Crows on Hardy 1990). The young Tamaulipas Crow voice in Fig. 3 was recorded on 17 August 1987, when it was about 9 days out of the nest.

On 10 September, there was little physical change in the voices of the juveniles, although the second sonogram (Fig. 4) illustrates a call that has a harsh terminal sound and an overall slightly noisier character. On 17 September and continuing through mid-October (Fig. 4 A-E), the even, arched tonal components of the birds' voices are broken and a gutturality (marked by the vertical segmentation) is evident.

This intermediate character—midway between adult Fish Crow and Tamaulipas Crow vocal character—persisted into early November. This stage was accompanied by the long-protracted first pre-basic (post-juvenal) molt of these birds, which involves all feathers except rectrices and remiges. Fig. 4F and G, from recordings made on 17 November, are of first year birds that had completed their molt and whose voices now more closely resembled the voices of adults of their own species. They retained only the merest trace of tonal structure and the dominating structural feature was the gutturality shown in the vertical segmentation in the sonogram.

Fig. 5, of sounds made by the young birds at about 6 months of age in January 1988, displays vocal character that is indistinguishable from that of their parents, with exquisitely precise vertical segmentation (like a fine-toothed comb) superimposed on one or two tonal centers. The young birds still lack repertoire, but in their cawing sounds they are Tamaulipas Crows.

DISCUSSION

I judge the significance of the above results to be in accord with Haeckel's Law that ontogeny recapitulates phylogeny. Thus, the odd-voiced Tamaulipas Crow is a close, derived relative of the Fish Crow. The Tamaulipas Crow's voice is the derived state, and the Fish Crow's voice is the primitive state, as discussed below. Young Fish Crows, I think

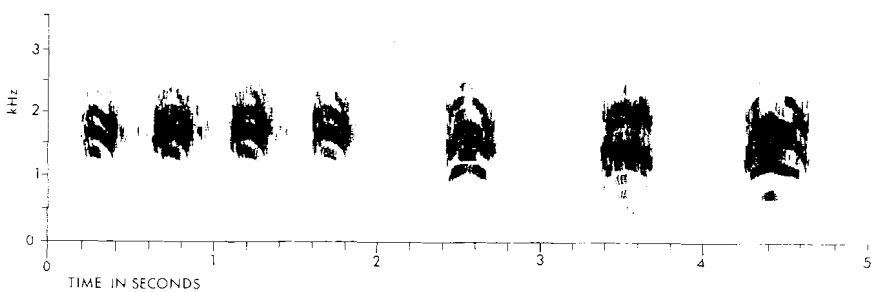

Figure 3. Sonograms of: left, adult Fish Crow; right, juvenal Tamaulipas Crow, about 9 days out of nest (ca. 39 days old).

significantly, sound very much like their parents, again lacking repertoire variety but having the same voice quality. One referee of an earlier version of this paper suggested an alternative hypothesis: that the Fish Crow is a neotenous, derived relative of the Tamaulipas Crow. However, some cawing vocalizations of the Fish Crow are very similar to such calls of the American Crow (*C. brachyrhynchos*), the Northwestern Crow (*C. caurinus*), and the Common Raven (*C. corax*) (hear on Hardy 1990). The

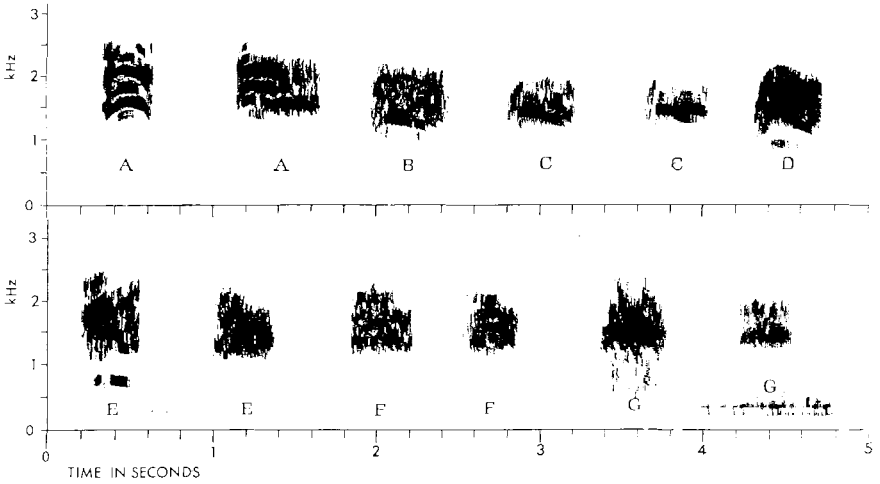

Figure 4. Sonograms of typical calls of young Tamaulipas Crows during post-fledgling through prebasic molt stages during 1987: A. 10 September; B. 17 September; C. 1 October; D. 12 October; E. 17 October; F. G. 17 November. These calls were losing their tonality and gaining vertical segmentation by mid-November.

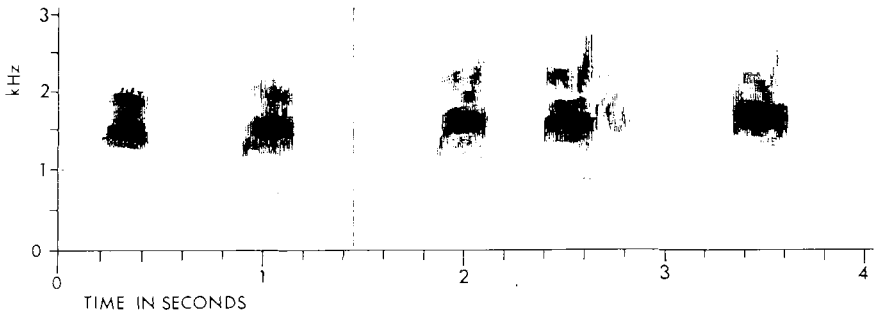

Figure 5. Sonograms of typical calls of: left, 6 month-old Tamaulipas Crows (in January 1988, molt completed); right, adult Tamaulipas Crows, illustrating that they were indistinguishable from each other.

widespread American Crow's cawing closely resembles that of the Palearctic Carrion Crow (*C. corone*) (hear on Kettle 1987). These two species are remarkably similar in nature, according to my personal observations. It is established beyond reasonable doubt (Mayr 1946, Sibley and Ahlquist 1983) that the crow-jay family (Corvidae) is part of the Australian Passerine assemblage (group III, Robin-Whistler-Monarch-Crow) that evolved from a single ancestral taxon, beginning ca. 65 MYA, near the Cretaceous-Tertiary boundary. Moreover the genus *Corvus* is represented by over 30 species in the Old World (Goodwin 1976), and these species show a great amount of morphological variation. In contrast there are only 10 to 12 species in the New World including Hawaii (AOU 1983). These show comparatively little morphological variation. One, the Common Raven (*C. corax*) is Holarctic in distribution, and another, the Carrion Crow, as discussed above, seems to be very closely related to the New World American Crow. Zoogeographically, therefore, American crows most closely resembling the Old World ancestral stock are those occurring north of Mexico. Based on this fact and on vocalizations as analyzed here, it would seem that the Tamaulipas and Sinaloa crows, not the Fish Crow, are the derived forms. The genus *Corvus* being of Old World origin, colonization of the New World has been from Holarctic to Nearctic to Neotropical.

I judge the North American crows to be an especially ripe topic for further systematic study. I wonder what young Sinaloa Crows sound like? I predict they will not sound much like their parents! I have already pointed out (Hardy 1979) how I believe that Sinaloa Crow-Beechey Jay (*Cyanocorax beecheii*) interaction may have led to the crow's evolvement of such an uncrow-like voice. There also is a clear need for biochemical studies that should shed light on the degree of relationship among North American crow species. Accordingly, near the close of the present investigation, Michelle Tennant and I extracted liver, heart, and pectoral muscle tissues of captive Tamaulipas and Fish Crows. These are in the frozen tissue bank of Dr. Michael Miyamoto, Department of Zoology, University of Florida. We need similar tissues of Sinaloa Crows, and ideally of the other North American *Corvus* before such studies. At this time I am not aware of any Sinaloa Crow tissues in preservation for biochemical analysis.

ACKNOWLEDGMENTS

I thank Tom Webber and the late Laurence Alexander for assistance in maintaining the birds in captivity. I also thank Amadeo Rea of the San Diego Natural History Museum and William D. Toone of the San Diego Wild Animal Park, San Diego, California, for arranging for me to receive the crows used in this study. I appreciate the guidance and cooperation of Michelle Tennant in the taking and preservation of body tissues for biochemical study and Michael Miyamoto for providing space for these frozen tissues in his laboratory.

LITERATURE CITED

AMERICAN ORNITHOLOGISTS' UNION 1983. Check-list of North American birds, sixth ed. Washington, D.C.: Amer. Ornithol. Union.

BORROR, D. J., AND C. R. REESE. 1956. Vocal gymnastics in Woodthrush songs. Ohio Journal of Science 56: 177-182.

DAVIS, L. I. 1958. Acoustic evidence of relationships in North American crows. Wilson Bulletin 70: 151-167.

GOODWIN, D. 1976. Crows of the world. Ithaca, New York: Cornell University Press.

GREENEWALT, C. H. 1968. Bird song: acoustics and physiology. Washington, D.C.: Smithsonian Institution Press.

HARDY, J. W. 1979. Vocal repertoire and its possible evolution in the black-and-blue jays (*Cissilopha*). Wilson Bull. 91: 187-201.

HARDY, J. W. 1990. Voices of the New World jays, crows, and their allies, family Corvidae. Gainesville, Florida: Audiocassette, ARA 9. ARA records.

HELLMAYR, C. E. 1934. Catalog of birds of the Americas. Field Mus. Nat. Hist. Publ. 330, Vol. 13.

KETTLE, R. 1987. British bird songs and calls. London: The British Library National Sound Archive. 2 boxed audiocassettes, booklet, NSA C5/6.

MAYR, E. 1946. History of the North American bird fauna. Wilson Bull. 8(1): 3-41.

SIBLEY, C. G., AND J. E. AHLQUIST. 1983. Phylogeny and classification of birds based on data of DNA-DNA hybridization. Pp. 245-292 *in* Current Ornithology, Vol. 1 (R. F. Johnston, ed.). New York: Plenum Press.

WEBBER, T., AND J. W. HARDY. 1985. Breeding and behaviour of Tamaulipas Crows, *Corvus imparatus*, in captivity. Avicultural Mag. 91: 191-198.

ANNOUNCEMENT

The Florida Ornithological Society announces its 1991 Helen G. and Allen D. Cruickshank Research Award in the amount of $500.00 for research dealing with Florida birds. Applicants should submit three copies of a proposal outlining goals, significance, feasibility and budget (including other funding anticipated) and a resume by 15 February 1991 to John W. Fitzpatrick, Archbold Biological Station, P. O. Box 2057, Lake Placid, Florida 33852. The recipient will be announced at the FOS spring meeting in April 1991.