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OBSERVATIONS ON THE BEHAVIOR AND ECOLOGY OF THE MARIANA CROW¹

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The Mariana Crow (*Corvus kubaryi*) is found on the islands of Guam and Rota in the Mariana Islands of Micronesia. An attractive, fairly tame island inhabitant, the Mariana Crow is small with short, broad wings, a green gloss to the black head plumage, and a blue gloss to the black body plumage. Patches of gray feather bases in the body plumage and white feather bases in the neck region are often exposed. The bill and feet are black, eyes are brown, and nasal bristles are prominent. As in other corvids, the juveniles have short, fluffy head plumage. In addition, young Mariana Crows are disheveled in appearance; exposed feather bases on the breast show as light patches, the black plumage has a brown cast, and flight feathers may appear worn at the tips. As suggested by Baker (1951), *C. kubaryi* may be closely related to *C. enca* of the Malayan and Philippine regions. He further speculates that "*C. kubaryi* is an isolated and modified species of crow, which probably has been living at Guam and Rota for a considerable length of time." Features which differ from the candidate ancestral species include small size, slender bill, and dull coloration. Goodwin (1976) believes, however, that aside from the geographic proximity of *C. enca*, any *Corvus* species could be ancestral.

The Mariana Crow is a little-known species whose populations have suffered declines over the past 25 years. In 1975, the crow was placed on the Trust Territory Endangered Species list; in 1984, it was placed on the U.S. Federal Endangered Species List along with the Bridled White-eye (*Zosterops c. conspicillatus*), Guam Flycatcher (*Myiagra freycineti*), Micronesian Kingfisher (*Halcyon c. cinnamomina*), Vanikoro Swiftlet (*Aerodramus vanikorensis bartschii*), Common Moorhen (*Gallinula chloropus guami*), and Guam Rail (*Rallus owstoni*; revised nomenclature, Pyle and Engbring 1985). Although a recovery plan for

Guam's endangered avifauna is currently in preparation, much of the anecdotal information available for these species has come primarily through the efforts of J. Mark Jenkins (1983).

I observed the Mariana Crow on Guam and Rota for 15 days during July 1980. Although the study was brief, the observations supplement the information in Jenkins (1983), presenting additional details on the ecology and behavior of the crow.

STUDY AREAS AND METHODS

The Mariana Islands lie above the Equator, midway between Japan and New Guinea and about 2000 km east of the Philippines; Guam and Rota are situated about 14°N and 145°E. Guam, a United States trust territory, is the largest and best known of the Mariana Islands. Rota, administered by the Commonwealth of the Northern Mariana Islands, lies about 59 km northeast of Guam. For both islands the year-round climate is humid, with daytime temperatures about 30°C or higher. Details concerning the geology, weather, flora, and fauna of Guam are available in Stone (1970), Moore and McMakin (1979), and Eldredge (1983). Plant communities referred to in this report are found on both Guam and Rota and have been described in detail by Moore and McMakin (1979) and Jenkins (1983).

I observed the Mariana Crow on Guam from 4 to 11 and 25 to 27 July 1980, in limestone forest and coastal

TABLE 1. Flock sizes observed for the Mariana Crow.

	Flock size	No. of times observed
Guam	1	5
	2	5
	4	1
	5	2
Rota	1	1
	2	10
	3	4
	4	3
	6	1

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TABLE 2. Vegetation used by Mariana Crows on Guam and Rota.

	Plant species	No. of times observed
Guam	<i>Pandanus</i> sp.	1
	<i>Leucaena leucocephala</i>	1
	<i>Cocos nucifera</i>	2
	Total	4
Rota	<i>Cocos nucifera</i>	5
	<i>Scaevola taccada</i>	4
	<i>Casuarina equisetifolia</i>	3
	<i>Hernandia nymphaeifolia</i>	3
	<i>Maytenus thompsonii</i>	3
	<i>Elaeocarpus sphaericus</i>	2
	<i>Artocarpus mariannensis</i>	2
	<i>Pandanus</i> sp.	2
	<i>Ficus prolixa</i>	2
	<i>Messerschmidia argentea</i>	1
	<i>Neisosperma oppositifolia</i>	1
	<i>Mangifera indica</i>	1
Total	29	

strand on the northern third of the island, which is now the only area where crows commonly occur (Jenkins 1983). Field transportation and logistic support were provided by the Division of Aquatic and Wildlife Resources (DAWR) on Guam. From 22 to 25 July 1980, I studied crows on Rota in more detail than I could on Guam, working primarily in coastal strand association 1 to 3 km northeast of the village of Songsong. Crow vocalizations were recorded at close range with a Sony T-55 cassette recorder and cardioid microphone and later transferred to reel-to-reel tape. In the Department of Zoology and Entomology at Colorado State University, I made sonograms on a Kay Elemetrics Sona-Graph, Model 7029A, for rough analysis.

OBSERVATIONS

FLOCK SIZE AND FLIGHT

I obtained flock size counts on a total of 32 crow sightings with an overall range of 1 to 6 crows per flock (Table 1). The mean flock sizes on Guam and Rota were 2.2 and 2.7 crows, respectively. Compared by *t*-test, the flock sizes on Guam and Rota did not differ significantly ($t = -0.972$, $df = 30$, $P = 0.170$). Jenkins (1983) reports flocks on Guam typically of 2 to 5 individuals but mentions one flock of 14 and another flock of 7, both in flight. J. Engbring, F. L. Ramsey, and V. Wildman observed larger flocks on average on Guam than on Rota.

Sightings of crows in flight were common on both Guam and Rota. The shape of the crows' wings appeared shorter and broader in comparison with American Crows (*C. brachyrhynchos*), perhaps permitting more maneuverability

in forests. Occasionally the flight pattern was like that of woodpeckers, with wings held to the sides during a glide. For fast flying, the flapping was of the pumping type typical of other crows. Crows flew above the forest canopy during most sightings on Guam. In contrast to the observations of J. Engbring, F. L. Ramsey, and V. Wildman (unpubl.), I observed crows flying above the forest canopy on Rota as well, but primarily on the southwest side of the island.

FAMILY GROUPS

Several of the crow groups observed on Guam and Rota consisted of two parents and one, two, or more offspring. On Rota, family groups appeared to occupy a defined home range along the coastal strand; one group was found in the same 2-km stretch for three consecutive mornings. The juveniles were particularly tame and occasionally perched no more than 1 m from me in the understory. As in other corvid species, the juveniles must have a long period of dependency, as several observed at close range did not have rictal flanges.

Squalling, persistent food-begging calls were common throughout the coastal strand on Rota and were occasionally heard on Guam. When most intense, the calls were accompanied by wing flutters and bill gaping. On Rota I observed that the begging juveniles were fed intermittently by a parent, and as the juveniles swallowed the food, they emitted a choking, yelping sound as do young of other crow species. In between feedings or when their parents did not respond, the juveniles often perched quietly or moved alone through the dense *Scaevola* understory. I observed one juvenile preen and then scratch its neck by lifting a leg over the wing. While juveniles traveled through the understory, moving from perch to perch or searching the ground, they would encounter and manipulate a variety of objects, apparently not consuming them. They snipped or ripped leaves from trees, hammered on branches, and played with seeds, snail shells, twigs, live and dead leaves. One juvenile was observed shredding bark from a twig by sliding the twig between the mandibles. Another juvenile placed a seed in a cup-like hollow, where two large branches joined in a *Hernandia* tree, and removed and replaced the seed in the hollow at least twice.

FORAGING BEHAVIOR AND VEGETATION USE

The Mariana Crow is clearly an omnivore, feeding both on plant and animal foods (Marshall 1949, Jenkins 1983). Crows commonly forage in the forest canopy, in the dense understory, and on the forest floor. On Rota I observed crows foraging on the fruit of *Artocarpus mariannensis*. Crows also searched the leaves of *Cocos nucifera* and *Ficus prolixa* and the bark of *Scaevola taccada*, presumably looking for insects or lizards. On one occasion, a crow pulled vigorously at the dead leaves of a *Pandanus* sp., which Jenkins (1983) has observed crows eating. In Table 2, I list all species of plants that I observed crows using on Guam and Rota for foraging as well as other activities

TABLE 3. Characteristics of vocalizations of the Mariana Crow, based on rough sonographic analysis.

Vocalization	Sample size	Dominant freq. KHz	No. of syllables	Syllable duration sec
Adult				
Locational call	4	2-3, 5-7	1-3	0.35-0.46
Squalling locational call	1	1.8-3, 5-6.5	2	0.50
Alarm call	2	1.8-3, 4-7	3-4	0.23-0.35
Juvenile				
Locational call	3	1.8-3, 4.5-7.5	2-4	0.23-0.35
Hunger call	6	2-3, 5-7.5*	1-3	0.31-0.77

* Strong harmonics, down-slurred syllables.

such as vocalizing, playing, resting, and feeding young. Of the 13 plant species used by crows, 11 were native and typical of coastal strand and limestone forest. The exceptions were the introduced *Leucaena* and *Mangifera* (mango). Similar foraging habits and behavior were described for the endangered Hawaiian Crow (*C. tropicus*) by Sakai and Ralph (1980).

VOCALIZATIONS

The vocalizations of adult crows heard on Guam and Rota were of four general types. (1) Locational calls, noted on eight occasions, consisted of high pitched caws or *hi* sounds given one to three times in succession. As the name indicates, locational calls were probably used to maintain contact among individuals of a pair, family group, or flock. Usually two or more crows were involved; sometimes one crow responded to a locational call with a locational call. The accompanying behaviors included perching, foraging, flying through or above the forest, and one crow leaving a nest using locational calls, followed shortly by its mate, also using locational calls. (2) Squally locational calls were nasal caws with an *aaa* sound used by a nesting pair on six different occasions. I heard the vocalization in the following contexts: given by a crow on the nest as another flew in, by both crows at the nest, and by a crow setting a twig in place on the nest (two occasions). This variation of the locational call may be used between mated crows. (3) The vocalizations under the category monolog include a variety of quiet or excited guttural and squalling sounds that were given for several consecutive minutes by members of a pair at the nest. While vocalizing, the crows ripped nearby leaves from a branch and dropped them from the tree or hammered on a limb. These calls may serve some courtship or pair-bond function. Similar calls and playful behavior are described by Kilham (1985) for American Crows. The "song" described by Brown (1985) for *C. brachyrhynchos* seems homologous in sound structure and context to the monolog in Mariana Crows. (4) Alarm calls consisted of a series of sharp, rapid caws. I heard this vocalization from two crows perched in a *Casuarina* tree when they were startled by the sudden appearance of several people. Measurements taken from sonagrams of three types of adult vocalizations are summarized in Table 3. The sonographic patterns are very similar to those of *C. brachyrhynchos* (e.g., Richards and Thompson 1978, Brown 1985), but of higher frequencies. As described by Brown (1985) for caws, the locational calls show dominant frequencies (defined by loudness) and also harmonic structure.

The vocalizations of juvenile crows are similar to those of adults. (1) Locational calls (heard on three occasions) were somewhat shorter in duration than those of adults but given in similar contexts. (2) Monolog consisted of a series of squalling, whining calls of varying inflection, given on three different occasions by a juvenile alone in the understory or with other crows perched nearby. During one observation, the juvenile simultaneously preened and scratched. (3) Hunger calls, heard on three occasions, consisted of a series of insistent *aaa* sounds with a rising inflection, often accompanied by wing flutters. The calls increased in intensity until the young bird was fed by a nearby adult. While gulping food, the juvenile made a gurgling sound. Table 3 summarizes measurements from sonagrams for two of the juvenile vocalizations. The hunger calls showed a pronounced harmonic structure; on 3 of 5 sonagrams, dominant frequencies were not readily apparent.

NEST CONSTRUCTION AND NESTING BEHAVIOR

On 25 July, I observed a pair of crows constructing a nest in coastal strand vegetation on Rota. The nest site was at

the junction between two large branches about 8 m up in a large *Hernandia nymphaeifolia*, which bore abundant fruit. Located near the dirt road parallel to the strand, the nest tree was approximately 2.9 km northeast of Songsong and next to a small Chamorro cemetery about 20 m from the beach. At an early stage of construction, the nest consisted of a skeletal platform and ring of twigs, about 50 cm in diameter. Details from my field notes follow.

At 0800 one crow flew to the nest carrying a long strand of *Casuarina* foliage, vocalizing both the locational calls and the squalling locational calls. After placing the foliage on the nest platform, the crow perched in a nearby *Casuarina* for 5 min and then flew off. By 0820 the crow and its mate returned, vocalizing squalling locational calls while flying to the nest tree. Both birds engaged in monolog calls for several minutes, while breaking off and dropping leaves and twigs and tapping branches in woodpecker fashion. One crow stood on the nest and cawed in an agitated manner. It is possible that both were disturbed by our presence (two observers); such reaction to human disturbance has also been observed by Jenkins (pers. comm.). However, the crow at the nest abruptly flew into the *Hernandia* foliage above the nest, picked up a twig, and returned to the nest.

After placing the twig on the platform, the crow on the nest vocalized squalling locational calls while the other crow flew off. The second crow returned at 0845, and both crows exchanged squalling locational calls. Both crows left the vicinity of the nest and returned together at 0905. One crow silently entered the nest while the other perched, gave squalling locational calls, and hammered on a limb. The crow on the nest flew into the *Hernandia* canopy, broke off a twig about 0.3 m long with its bill, returned to the nest platform, and set the twig in place; the crow repeated this behavior twice again. Pausing, it gave squalling locational calls, which were answered by the other crow, perched nearby. The crow on the nest entered the *Hernandia* foliage again and found a fourth twig, but it then flew off (at 0918), twig in bill, vocalizing the high-pitched locational calls. The other crow followed immediately, vocalizing similarly. Since the crows did not return to the nest by 1000, I continued my observations elsewhere.

When I returned to the nest tree at 1115, one crow was on the nest and the other was perched in a nearby tree. I could not tell whether the crow on the nest was the same individual observed there earlier. However, the crow soon moved into the *Hernandia* canopy, broke off a slender twig, and dropped it. Quickly, it then broke off a long, sturdy branch, about 0.5 m long, and arranged it in the nest platform. The other crow softly vocalized monolog calls. At 1115 both crows flew off. Unfortunately, I had to terminate observations that afternoon.

Marshall (1949) suggested that Mariana Crows may have a limited breeding season; he stated that the crows do not breed in May, June, or July. This suggestion was supported by Baker (1951) who did not find crows in breeding condition from May to September. However, DAWR staff observed fledglings with adults in May, June, September, and October, which indicated that the crows breed year-round (Jenkins 1983). The observations presented here of nest building on Rota in July substantiate that possibility.

Although I report that only one crow appeared to engage in nest construction, DAWR staff have observed both members of a pair carry nest material (Jenkins 1983; R. E. Beck, pers. comm.). Additional observations at an active crow's nest confirm that both mates incubate eggs and feed the young (Jenkins 1983). Kilham (1984) reported that both members of pairs of American Crows engaged in nest construction; however, only the female incubated the eggs and brooded the nestlings.

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ERRATUM

In our May 1986 issue, the authors' names for the article "Costs of adoption in Western Gulls" (Condor 88:253-256) appeared incorrectly. The authors are Harry R. Carter and Larry B. Spear.