THE BREEDING BIOLOGY OF THE TUFTED JAY

by

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STATEMENT BY AUTHOR

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ABSTRACT

The various aspects of the breeding cycle of the Tufted Jay (*Cyanocorax dickeyi*) are described. Other associated factors such as range, habitat, vocalizations, and food are discussed.

The Tufted Jay is restricted to a relatively small area in western Mexico. Its barranca habitat contains many tropical floral and faunal elements which reflect its close relationship to other tropical members of the genus *Cyanocorax* in South America.

The Steller’s Jay (*Cyanocitta stelleri*) occupies the same geographic range as the Tufted Jay. The two species differ in feeding behavior and habitat preference and probably do not compete to any extent.

The Tufted Jay is highly social and flocks are maintained throughout the breeding season. Only one pair mates in a flock; the other members help to build the nest and feed the incubating female and nestlings. This social breeding behavior appears most similar to that of the Brown Jay (*Psilorhinus mexicanus*). The low reproductive rate of the Tufted Jay is considered one of the major reasons for its comparative rareness and limited range. It is considered a relict species representing primitive *Cyanocorax* stock, which probably once ranged widely throughout the American tropics.
INTRODUCTION

The Tufted Jay (Cyanocorax dickeyi) occurs only in a relatively small area of the Sierra Madre Occidental of western Mexico. Its closest relatives are Cyanocorax mysticalis, C. chrysops, and C. affinis, all in northern South America, although C. affinis does range north to eastern Costa Rica. The Green Jay (Cyanocorax yncas) is the only other jay in the genus occurring north of Panama, but it does not appear to have close affinities to C. dickeyi.

The first specimens of this magnificent jay were secured in the fall of 1934 by Chester Lamb at Rancho Batel, five miles northeast of Santa Lucia in southeastern Sinaloa. Moore (1935:274) indicated the unusual distributional aspects of this species in stating:

The extension of the range of the genus 2000 miles to the north is as surprising, as that so conspicuous a bird has not been discovered previously by expeditions, which have crossed Sinaloa a short distance north and south of its mountain habitat. That its range is restricted is manifest. Assiduous collecting for the past three years by Messrs. Lamb and Wright in different areas of the mountains of southern Sonora and northern and southern Sinaloa, and previous collecting by J. H. Batty to the south and also to the east in Durango have not revealed a single specimen. Batty spent an entire year within 75 miles of its habitat and for a month combed identical altitudes on La Balla and Juan Lisiarraga Mountain not 35 miles away!

Other more recent workers have fared little better at finding the birds. Although a considerable number of specimens has since
been collected, both by Lamb and others, the majority of these birds was taken in and about the general vicinity of Rancho Batel, the type locality.

After an unsuccessful attempt at finding the nest of the Tufted Jay in April 1936, Moore succeeded in a second attempt in May 1938. His interesting account of that trip (Moore, 1938) was the only intensive study made of the species until the present one.

I first became acquainted with the Tufted Jay while on a collecting trip through southern Sinaloa in 1961. Three days of searching in the vicinity of Rancho Batel had not yielded a glimpse of the species, and I had given up hope of seeing it when a local hunter brought in seven specimens.

Since this rare jay occupied such an unusually limited range and was relatively unknown in regard to breeding behavior, I made additional trips to the area in the next two years in order to learn more of the habits and habitat of the species. These short trips combined with a five-month investigation in 1964 constituted the field work for the present study.

All Mexican residents familiar with the Tufted Jay called it "urraca pinta", literally, the Painted Jay. The Spanish vernacular name of "Urraca de Dickey" given for this species in the Mexican Check-list (Miller et al., 1957:128), is completely artificial and is neither known nor used by the inhabitants in the bird's range.
METHODS AND MATERIALS

The study area was located in southeastern Sinaloa near the border with Durango and spanned a distance of approximately 10 air miles in an east-west direction (see Figure 1). Small portions of the study area could be traversed by jeep using abandoned logging roads, but most areas actually occupied by the jays could be reached only by foot.

Four one-week trips were made to the study area during the years 1961 through 1963. The period from 8 February through 12 June 1964 (with an absence of 16 days in March) was spent in the area.

Several flocks of Tufted Jays occupied established home ranges throughout the study area. I attempted to study as many flocks as possible, but due to the difficulty involved in traveling about the area, all flocks studied did not receive equal observation time.

Due to the extremely rough terrain, flock movements during feeding and food-gathering were best observed from a high vantage point such as a cliff overlooking a broad expanse of barranca. Much of the approximate home range boundary of each flock was determined in this manner.

Tufted Jays were tame enough, especially about the nest sites, to be observed with 7x35 binoculars. After the members of a flock
became accustomed to my presence, they usually ignored me.

Nests, and the respective flocks associated with each, are numbered in the order in which the nests were found during the study period in 1964.

I used Japanese mist nets many times in attempts to capture birds in order to color band them, but since the jays are almost completely arboreal feeders, I captured and banded only three individuals. Even when nets were placed in places where the jays passed frequently, their slow intent manner of progressing in short flights invariably allowed them to see the nets in time to avoid them, although I caught hundreds of migrating warblers and numerous other birds. Baited traps placed on the ground (which are so successful in capturing other species of jays) failed to attract Tufted Jays.

I acquired a nestling Tufted Jay in the spring of 1963 and another in 1964. Observations of these two captive birds (so designated in this report) supplement observations made in the field.

I noted any interactions between Tufted Jays and Steller's Jays (Cyanocitta stelleri) in an attempt to elucidate the behavioral relationships of the two species.
RANGE

The Tufted Jay is an endemic Mexican species restricted to the Pacific slope of the Sierra Madre Occidental in the states of Sinaloa, Durango and Nayarit. The entire range encompasses an area of roughly 120 x 20 air miles (see Figure 2). The central Nayarit record (Sierra de Nayarit) given in the Mexican Check-list (Miller et al., 1957:128) pertains to C. Lamb's Nayarit collecting sites: 10 miles northwest of Santa Teresa, and Rancho La Mesa in the Sierra de Nayarit near Santa Teresa. The Santa Teresa referred to by Lamb is in northern Nayarit and is not the larger town of that same name located in central Nayarit, as implied in the Check-list.

Tufted Jays are most numerous between 4500 and 7000 feet above sea level, but Lamb collected birds as low as 3900 feet near Rancho Batel, Sinaloa and J. Davis found them at 8200 feet at Neviero, 4 miles west of La Ciudad, Durango. In both cases the birds were collected after the breeding season and presumably represent post-breeding dispersal from the nesting localities.
HABITAT

Elevations within the study area range from about 4500 feet in the lower barrancas to the west to slightly over 7000 feet along the higher ridges on the eastern border. Within this range the terrain is exceedingly diverse, but consists primarily of prominent ridges and deep barrancas (see Figure 3). The sides of the barrancas are normally quite steep and in places sheer cliffs extend 1500 feet and more from the tops of ridges to the bottoms of barrancas.

As is typical in northwestern Mexico, rainfall in the study area is restricted primarily to the summer months of June, July and August, and by the end of the dry season in late May, most of the small streams in the higher elevations are dry or reduced to small trickles. There is considerable underground seepage, however, as indicated by the flow present in many of the streams at slightly lower elevations, even at the height of the dry season. Some winter rain occurs, primarily in November and December, but it is not consistent as are the summer rains (Shreve, 1937:606; Gentry, 1942:12). During 1964, for example, no rain fell in the area from 12 February to 21 May, although considerable cloud cover was often present, especially during May. Freezing temperature sometimes occurs at higher elevations.

At my first camp west of Rancho Carrizo (elevation ca. 6000 feet), ice
formed on small pools in the stream several nights during late
February 1964. However, at a ranch located a few miles to the west
at an altitude of approximately 5500 feet, Bougainvillea grew luxuri­
ously about the ranch house, a good indication that freezing tempera­
tures were absent or very mild.

The entire area is rather heavily grazed by cattle and goats,
with the result that small herbaceous plants are scarce. Cattle often
attempt to feed too close to the edges of the precipitous barrancas and
many are killed by falls.

The vegetation of southeastern Sinaloa is little known. How­
ever, the vegetation at Sierra Surotato in northern Sinaloa as described
by Gentry (1946:452-462) shows many similarities to that encountered
in the study area. Vegetation within the study area consists of two
major types: (1) oak or pine-oak woodland, and (2) mixed deciduous
and evergreen riparian woodland (see Figure 4). The oak and pine-oak
forms are often sharply separated from the riparian associations, but
in places the two zones blend into one another with a mixture of species
of both types.

The oaks and pine-oak forms are generally restricted to the
ridges and the few mesa areas present, but where the slopes are grad­
ual, these forms are continuous into the barrancas, and it is here that
mixing with riparian species occurs. On some of the higher ridges
and mesas small areas of pine forest are found. The more common
pines in the area are *Pinus oocarpa*, *P. lumholtzii*, and *P. herrerai*. Extensive lumbering operations throughout the area, especially during the late 1940's and early 1950's, have resulted in almost total absence of large pines, except for occasional trees in inaccessible barrancas. The area is recovering well, however, and extensive stands of second growth trees up to 25 feet in height are present over most of their original range. Oaks are prominently represented by *Quercus endlichiana*, *Q. fulva* and *Q. viminea*. *Quercus pennivenia* occurs abundantly on certain dry, south-facing slopes with conspicuous white chalky soil. Many of the larger oaks such as *Q. endlichiana* have also been logged, but numerous large, gnarled specimens still remain. Prominent stands of Mexican Fir (*Abies religiosa*) were found on the moist, sheltered north-facing slope of a large barranca at Rancho Liebre, ca. 2 miles northwest of Palmito, but this species was never encountered west of this site.

In the barrancas along the stream courses the vegetation may appropriately be termed gallery forest. Among the common and conspicuous trees within these barrancas are *Magnolia shiedeana*, *Arbutus glandulosa* and *Ostrya virginiana*. The often dense understory may include *Clethra lanata*, *Senecio seemanii* and *Cerocarpus macrophyllus*. Certain fruiting trees such as *Peltostigma eximium* provide food for White-throated Robins (*Turdus assimilis*), Brown-backed Solitaires (*Myadestes obscurus*), Eared Trogons (*Euptilotis neoxensis*), Mountain

Epiphytic plants are well represented in the barrancas, both on riparian trees as well as the pines and oaks when these latter forms were present in the barrancas. Epiphytes include bromeliads (see Figure 5), orchids, ferns, lichens and mosses. Most common of the epiphytes are two species of *Tillandsia* (*exserta* and *benthamiana*). Orchids are represented by *Oncidium*, *Laelia*, *Isocholus*, and *Epidendrum*. Mistletoe (*Psittacanthus*) was abundant in certain areas, usually on oaks. The mistletoe berries were a very attractive food source for Blue-hooded Euphonias (*Tanagra musica*) and Mexican Ptilogonys (*Ptilogonys cinereus*). A sharp gradient of microenvironments was often evident in the barrancas. Secluded moist areas along the streams occasionally supported tropical bamboo-palm (*Chamaedorea*) and Begonia, while a short distance away Agave was present on the relatively dry barranca slopes.

During the study period (February-June), the Tufted Jays mainly utilized the moist, heavily vegetated barrancas for nesting and feeding. However, A. L. Gardner (personal communication) found
them commonly in the oak and pine-oak belts during the fall months in Nayarit. P. Hubbell also informed me that he observed Tufted Jays feeding along the pine-oak ridges near the study area in September 1964. Presumably the jays are attracted to the acorn crop during the fall months.
FLOCK COMPOSITION

A total of seven flocks were present in the study area. The smallest flock consisted of four birds, three others contained seven each, two contained 12 each, and the largest flock was composed of 16 birds.

Because of the remoteness and relative inaccessibility of the terrain occupied by certain flocks, all were not given equal observation time, but flock size and approximate home range boundaries were determined for all groups. I use the term home range instead of territory in these cases because, in the strict sense of the word, territory means a defended area. I never observed two flocks coming in contact with one another during the breeding season, and thus observed no actual territorial defense. However, Swanberg (1951:550) did not observe any true territorial fights or any consistent defense of the territory in the Thick-billed Nutcracker (Nucifraga caryocatactes), yet a marked pair was known to hold the same territory for 10 years. The Tufted Jay flocks used distinct areas for feeding and other activities during the breeding season. The situation appears much the same as that described by Hardy (1961:49-50) for the Mexican Jay (Aphelocoma ultramarina arizonae):
Home range of flocks are separate with no overlapping during the time of breeding activity. Although I have never observed any behavior of the species that might be termed territorial aggression, the distinctness of the ranges of breeding flocks implies the presence of a spacing mechanism that is the effective equivalent of territoriality.

Perhaps the areas occupied by flocks have been maintained over many generations; the flocks are relatively sedentary, the habitat nearly unchanging over the years. The change in individual composition of the flocks by old birds dying off, young birds taking their place is gradual. The young birds each year learn the boundaries of the home range by following their parents and associated adults of the flock. The boundaries have themselves been established so that sufficient food, shelter, roosting places, water, and other necessities are present to allow the existence of the flock, which remains fairly constant in size.

There was some indication that Tufted Jay flock size might be correlated with characters of the terrain and vegetation. In the case of each of the three largest flocks, the home ranges contained extensive areas of wide barranca supporting continuous stretches of large shade trees with dense understory vegetation. Those areas occupied by smaller flocks contained shaded areas of more limited extent.

One apparent case of flock splitting involved a flock of 11 birds which was observed regularly during February 1964. After 20 February two smaller groups of four and seven were observed. These two flocks then remained constant in size throughout the remainder of the study period, each occupying a portion of the foraging area over which the combined flock of 11 had wandered earlier. None of the birds were color-banded at the time of the splitting. Because of the foraging area and the number of birds involved, however, I feel
reasonably certain that the individuals which made up the flock of 11 were the same ones which eventually formed the two smaller flocks. At the active nest site of each of the smaller flocks during 1964, there was a nest of the previous year nearby. Apparently the two groups had been separate the previous breeding season. This case suggests that small flocks might form larger aggregates during the winter months with subsequent breakup as the nesting season approaches.

The age composition of a flock cannot be determined with any degree of certainty. Bill color used in determining age by Pitelka (1945:256) for the Mexican Jay (Aphelocoma ultramarina arizonae) and by Skutch (1960:254) for the Brown Jay (Psilorhinus mexicanus) cannot be used for the Tufted Jay. In juvenal birds the basal portions of the mandibles are flesh color, but this character disappears during the first few months and the entire bill is black externally from that time on. For at least one year the distal portions of the mandibles are horn-colored internally, but this character obviously cannot be used in the field. Three plumage characters exist, however, which make it possible to determine the age of birds up to the time that the second winter plumage is obtained. (1) The suborbital spot and entire malar region is blue in first-year birds, but replaced by white in adults. (2) The large semilunar superciliary patch is white in adult birds, but it is black like the rest of the crest region in first-year birds. (3) The crest itself is relatively short (ca. 22 mm.) in first-year birds and longer in adults.
The iris of juvenile birds is dark smoky brown, but this changes to chrome yellow early during the first year and is not coincident with plumage changes. After the second winter plumage is obtained, age is conjectural. Birds assumed to be in their second year have shorter crests (ca. 27 mm.) and do not appear to be as heavy bodied as presumed adults of three or more years. That this last character might have some validity is shown by the weights of birds aged by crest length. The average weight of three presumed second-year birds was 169.5 gm., while that of three apparently "old" birds was 190.6 gm. Associated with the attainment of large crests (up to 44.5 mm.) in suspected "old" birds is the appearance of a deep blue spot at the base of the crest just above the lores. This is often conspicuous enough to be easily visible in the field.

In all flocks observed, there were from one to four first-year birds, one or more assumed second-year birds, and at least two that were judged to be three or more years of age. The mated pair of each flock directly concerned with the nest always fell into this last category. Behavior exhibited by the mated pair of each flock such as duet calls, caressing of bills etc. was never observed between other members of any flock. Apparently there existed only one mated pair in each flock.

It may be noted that captive jays did not precisely follow the molt pattern of wild birds. In my two captive birds much of the blue malar region turned to the characteristic white of adults in the
postjuvenile molt and portions of the black superciliary patch also were molted at this time. The iris color, however, remained brown as in wild birds of comparable age. Changes such as those of diet, temperature, and elevation associated with captivity may account for these plumage differences. Brown (1963:130) noted variation in the attainment of adult bill color in captive Mexican Jays compared with wild jays.
Pre-Nesting Foraging Behavior

During February and March before nesting got under way, the individual flocks maintained themselves as units throughout the daily feeding movements. The flock regularly left the roosting area early in the morning, usually before full light. Roosting areas usually corresponded to later nesting sites; these being dense, secluded sites in barrancas overshadowed by large broadleaf trees. As the birds moved out from the roosting site, they first investigated the crowns of these large trees. The two species of large epiphytic Tillandsia were of primary interest in these trees. The birds often tore these plants apart in their endeavors to secure food items from the leaf axils. My investigations of these bromeliads showed them to contain numerous acorns, seeds, and other small fruits that had fallen into the cupped leaves, plus a variety of insects which inhabit the moist axillary spaces. The Tillandsia are tough and fibrous and the birds often employed considerable force in tearing leaves from these plants. The jays used a series of sharp blows in the process, which they supplemented by grasping the leaves in their bills and applying a sideways tearing motion. Food items not eaten on the spot, such as snails and acorns, were carried to nearby limbs and broken down into smaller fragments.
These items were grasped with one foot and struck sharply with the bill. In observing tame captive jays engaged in this behavior, I was impressed by the birds' ability to strike food objects in precisely the same spot with series of rapid, forceful blows.

Although Tillandsia held a special attraction for the birds, other epiphytes such as orchids, ferns, lichens, and mosses were also investigated. Certain fruiting trees such as Peltostigma eximium provided much food. Berries borne at the ends of branches too small to support the birds in an upright position were often taken while the birds hung in a typical parid fashion. At times the jays fed trogonlike, i.e., by hovering momentarily in front of berry clumps to glean the fruits.

In going from one barranca to another, the birds moved slowly up the cliff facings in short flights and investigated the large branched inflorescences of Agave and grass clumps in the rock crevices. Agave inflorescences often held a bird's attention for minutes at a time; the bird would tear the flowers open to secure either imbedded portions of the flower or perhaps insects that were drawn to the nectar.

During this time of the year, acorns were practically non-existent on the oaks, and the birds paid attention only to the various epiphytes in these trees. Pine-oak stands usually consisted of many small second growth trees, and these were relatively free of large bromeliads and other epiphytes.
In terms of total daily feeding time, I estimated the approximate percentages of time spent foraging in the various vegetation zones as follows:

- Mixed broadleaf barranca trees -- 50%
- Pure oak stands or oak and associated broadleaf -- 25%
- Grass and Agave studded cliffs -- 15%
- Pine and pine-oak -- 10%

These periods of time might vary slightly from day to day; some days being spent by certain flocks almost entirely in broadleaf zones of barrancas. At such times the cliffs, oaks and pine-oak stretches were quickly traversed in moving from one barranca to another.

The morning feeding movements normally lasted for about four-and-a-half hours. Intermittent periods of rest are included in this time. The birds may travel in a rough circle and arrive either back at the favored roosting area or some similar shaded spot. They then may spend several hours in large trees preening or resting. The distances traveled during a morning's feeding excursion depended greatly upon the extent of the various vegetation zones present in the feeding area, but averaged from one to three miles. One flock might have to traverse large stretches of relatively unprofitable pine or young pine-oak stands, whereas such vegetation might be scarce in the feeding area of another flock.
A second feeding excursion normally began in the early afternoon, and lasted until dusk, usually terminating at the roosting area. These afternoon feeding activities may or may not be over the same area used in the morning. During this period before nesting began, the respective flocks passed over much of the available habitat which they later utilized.

Foraging Behavior During Breeding

After nesting began in late March, three marked changes in the foraging behavior were evident. (1) Flocks tended to break up into smaller groups when going out on feeding excursions, e.g., a flock of seven might break up into two groups of three while the female incubated or brooded. (2) The flocks made numerous short trips away from the nest to feed or gather food instead of two long feeding excursions during the day. A small group might make as many as three or more trips to a fruiting tree and back to the nest within an hour. (3) The long periods of resting and preening which took place during the midday were shortened considerably and averaged no more than an hour when young were being fed in the nest. However, intermittent periods of rest took place about the nest site in between feeding or food-carrying excursions.

With the above changes in the feeding behavior during the breeding season, it was evident that the birds were now utilizing
considerably more of the available habitat. Not only were the main feeding areas visited more often, but adjacent small side barrancas were now utilized. There was, however, no change evident in the boundaries of the over-all feeding area for any given flock.

Tufted Jays regarded certain foods as delicacies, or so it seemed to me on the basis of the manner in which such items were sought. On several occasions I observed birds intently searching small oaks and other associated trees for large green katydids. That these insects were the objects of their search was quite evident by the excited manner in which the birds would pursue one after it was discovered. In one instance a jay somersaulted through the air after a katydid which it successfully captured in the air. In another similar case of aerial pursuit, a jay followed the insect to the ground and captured it within 12 feet of me. This was the only occasion on which I saw a wild Tufted Jay on the ground. On another date two birds tumbled from a tree after one of these insects and in their pursuit subsequently disappeared from view into a steep barranca.

Eggs and nestlings of other species of birds were also eaten by the jays. I observed a jay flying through camp early one morning with a white egg in its bill, the fresh contents dripping out as the bird flew from tree to tree in an attempt to keep up with the flock. From the size and color of the egg, I thought it to be that of a Band-tailed Pigeon. On several occasions I saw jays being mobbed by White-throated
Robins, White-eared Hummingbirds (Hylocharis leucotis), and Brown-backed Solitaires. The jays, apparently oblivious to the attacking birds, devoured the nest contents of the frantic robins. Although the solitaires and hummingbirds nested close to the ground and were probably not molested by the jays, the frenzied calls of the robins presumably stimulated them to join in the attack. Concentrated nesting of local birds occurs over only a brief period of the year and eggs and young birds apparently do not make up a very substantial portion of the jays' diet.

Analysis of stomach contents of specimens collected during the months from February through June revealed a preference for plant material, but nevertheless many insects were taken (see Table 1). The analysis suggests that the Tufted Jay feeds upon certain plants and takes associated insects in a casual manner. Insects were in the size range of 15 mm. to 50 mm. with a 25 mm. to 50 mm. preference. The scarcity of ground forms of insects and mud indicates (as did the foraging observations) that the Tufted Jay does little, if any, ground feeding. It is apparent from both the foraging observations and the analysis that the Tufted Jay, like most corvids, is omnivorous.

I made relatively few observations on the foraging behavior of the Steller's Jay. In practically all instances, however, they were observed feeding in pines and oaks and often beneath such trees. A great abundance of mud and ground forms of insects present in every
Table 1

Per cent composition of animal, vegetable and mineral material in stomachs of two species of jays collected in the study area in Sinaloa, Mexico.

<table>
<thead>
<tr>
<th>Food Item</th>
<th><em>Cyanocorax dickeyi</em> N = 22</th>
<th><em>Cyanocitta stelleri</em> N = 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coleoptera</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tenebrionidae</td>
<td>45.5</td>
<td>14.3</td>
</tr>
<tr>
<td>Scarabaeidae</td>
<td>13.6</td>
<td>71.4</td>
</tr>
<tr>
<td>Cerambycidae</td>
<td>31.8</td>
<td>26.8</td>
</tr>
<tr>
<td>Curculionidae</td>
<td>14.3</td>
<td>14.3</td>
</tr>
<tr>
<td>Buprestidae</td>
<td>9.1</td>
<td>28.6</td>
</tr>
<tr>
<td>Lepidoptera</td>
<td>4.5</td>
<td>14.3</td>
</tr>
<tr>
<td>Hymenoptera</td>
<td>45.5</td>
<td>57.1</td>
</tr>
<tr>
<td>Polistidae</td>
<td>40.9</td>
<td>14.3</td>
</tr>
<tr>
<td>Orthoptera</td>
<td>9.1</td>
<td>14.3</td>
</tr>
<tr>
<td>Hemiptera</td>
<td>4.5</td>
<td>14.3</td>
</tr>
<tr>
<td>Homoptera</td>
<td>4.5</td>
<td>14.3</td>
</tr>
</tbody>
</table>

| Arachnids    |                               |                               |
| Lycosidae    | 4.5                          | 14.3                        |

| Vegetable    |                               |                               |
| Acorn Meat   | 40.9                         | 85.7                         |
| Plant Fibers | 72.7                         | 57.1                         |
| Seeds        | 54.5                         | 14.3                         |
| Fruit        | 18.2                         | 14.3                         |

| Mineral      |                               |                               |
| Mud          | 9.1                          | 100.0                        |
| Gravel       | 90.9                         | 85.7                         |

Per cent of total food volume excluding mineral matter (based on a visual estimate).

| Plant Material | 71.6 | 70.7 |
| Insects        | 28.4 | 29.3 |
|                | 100.0% | 100.0% |
case in the stomach contents of Steller's Jays from the study area indicates that this species is predominantly a ground feeder. Occasionally they were observed feeding upon *Peltostigma eximium* berries, the only food seemingly common to both species of jays. Both the stomach analysis and feeding observations indicate that the Tufted Jay and the Steller's Jay probably do not compete for food to any great extent.
INTERSPECIFIC HOSTILITY

Instances of interspecific hostility were rarely noted during the study. Since the Steller's Jay was also a common resident of the area, I attempted from the onset of the study to try to determine the behavioral relationships of the two species. The interactions were both unclear and at times perplexing. One to three Steller's Jays were associated with each flock of Tufted Jays. These would often follow the Tufted Jay flocks about for long periods during the morning or afternoon feeding activities. Their positions during these movements were usually at the margins of the Tufted Jay flocks or immediately behind them. At first I assumed that the Steller's Jays might be obtaining food that had been disturbed or left behind by the larger Tufted Jays, whose feeding habits often involved tearing up various epiphytes, etc. This appeared not to be the case, however, for the Steller's Jays rarely fed during these movements. The Steller's Jays always appeared to be intently watching the Tufted Jays. Often I located flocks of Tufted Jays by first hearing the harsh, "scolding" calls of the accompanying Steller's Jays.

I noted antagonistic behavior on only two occasions. On 13 February 1964, a Tufted Jay made a short dive toward a Steller's Jay while the flock consisting of the two species fed on a cliffside. A
similar incident occurred on 2 April 1964 at Tufted Jay nest 2 while it was under construction. Most of the flock of seven Tufted Jays were perched in the large trees overshadowing the nest site. A Tufted Jay made a short flight toward a Steller's Jay, but the smaller, more agile Steller's Jay seemed to anticipate the movement and quickly flew out of the way. On numerous other occasions I saw Steller's Jays in the large trees near Tufted Jay nest sites; they were always ignored.

The only other instance of antagonistic behavior on the part of a Tufted Jay occurred on 24 April 1964 at nest 3 when the incubating female left the nest and dived repeatedly at a squirrel (*Sciurus sinaloensis*) that had ventured too near the nest site. The enraged diving jay pursued the squirrel for about 40 yards through the trees before it finally escaped in the dense underbrush. The jay voiced loud rak calls repeatedly during the chase and shortly afterwards returned to the nest to incubate. On many occasions with other flocks, I saw jays and squirrels feeding in close proximity. At nests 1 and 2, squirrels were noisy and conspicuous in nearby trees but were never molested by any of the flock members.

Smaller birds invariably ignored the Tufted Jays, except when their nests were being robbed by the jays.
The vocal repertoire of the Tufted Jay is highly variable. Certain basic calls, often quite variable in themselves, are used by all members of a flock and are easily referable to characteristic associated behavioral patterns. Most common among these is the **rak** call (Figure 6, A) which is commonly given in groups of four notes, but at times five or even more are uttered in quick succession.

Phonetic descriptions of calls are often extremely difficult. I have variously interpreted the basic note in this call as sounding like **rak**, **ruk**, **rook**, **tuk** or **pik**. Dr. J. W. Hardy (personal communication) thinks it sounds like **tic** or **chek** and is presumably the call referred to by Moore (1938:236) as **ca** or **tut**. This is by far the most variable basic call of the species. A rapid high-pitched version is used by all members of a flock in defense of the nest or young. In such excited moments as this, there is a tendency for the birds to utter more than four notes in quick succession. During "nest-sitting" and early stages of incubation, the females occasionally call a loud single note from the nest; in this case it sounds distinctly like **ruk** or **rook**. The incubating females also use this call, usually in series of four or five notes, when returning to the nest. The single-note calls from the nest do not appear to be a summons for the mate or other flock members to bring food as
Skutch (1960:239) claims is the case in the female Brown Jay which also calls from the nest. Occasional low-intensity *rak* calls, in series of two to four notes, are used by all members of a flock during normal feeding activity. I first heard a young captive bird use low-intensity calls of this type at about 43 days of age. When older, both captive birds used many variations of this call.

A low-intensity, nasal *aaagh* (Figure 6, B) was the second most common call used by all members of a flock. This appeared to be a recognition call directed towards other members of a flock. When one or more members of a flock were quietly perched about during rest periods, any jay entering into the immediate vicinity of those already present, uttered a drawn out utterance of this call. This was usually begun in the final stages of flight before landing near the other birds. The same call was always returned by at least one of the birds already present. Since the call is relatively subdued and is uttered with the bill closed, it was often difficult to determine how many of the positioned birds actually indulged in the vocalization. This call was also used by any member coming up to the nest with nest material or food. At times, however, helpers uttered the call when approaching the nest whether or not other members were present at the nest or in the immediate vicinity. Incubating females, however, did not use this call when returning to the nest after an absence. The call is usually voiced more than once by birds bringing food to the incubating female
or young, and is decidedly of a higher intensity than that given on other occasions. A young captive bird used this call soon after learning to eat by itself (at about 27 days of age). In this case the calls were directed at me whether I approached the bird or vice versa. At this early age the call was given only when the bird did not desire food; otherwise the begging food call was uttered. This begging call does not sound different from that of other young jays, crows (Corvus brachyrhynchos) or ravens (Corvus corax). Strangely enough, the incubating females used this same begging call when accepting food from another flock member (Figure 6, C), and even uttered the same familiar gurgling sounds like those of young birds when swallowing food.

Another prominent vocalization is a ped-el or pid-it call (Figure 7, A) similar in its bell-like quality to the cleeop call of the Blue Jay (Cyanocitta cristata) as described by Hardy (1961:21). This call is used during feeding activity by the Tufted Jay and apparently serves as a signal for flock movement. One bird in a feeding flock gives the call. This is immediately followed by the same type of call from other flock members, and the birds then take flight to a new feeding site. The movement takes place in a quiet orderly fashion, however, with no apparent sign of alarm.

I noted a high-intensity wheeuh call on three occasions. The first occurred when two jays of a flock of 11 were observed flying rapidly through dense gallery forest in a barranca. Only one of the
two appeared to be calling. At this time the flock apparently split up into two groups of four and seven. Two days later I heard a member of the newly formed flock of four calling in this manner, but dense vegetation prevented me from viewing any associated behavior. The adult female of this flock of four gave this call once as she left the nest during the early stages of incubation. Other than these three occasions, I did not hear this particular call from any members in other flocks, and while the bird in question was not identified on the first two occasions, there is the possibility that this same female may have given the call in all three instances.

Several calls were heard from males of different flocks as they stood "guard" about the nest sites while the female incubated. These calls were uttered when the males were apparently aware of and seemingly concerned about the presence of intruders. The calls include (1) a highly metallic ricochet (Figure 7, C) of one resounding note, (2) a call somewhat similar to the preceding one but composed of several notes repeated in rapid order, (3) a low-intensity tuk, normally repeated five times in quick succession, (4) a double-note tst; this call is difficult to describe, but can be duplicated by placing the tongue on the roof of the mouth and applying a sucking force, (5) a call which can best be described as a rapidly repeated, mellow "hoot" (Figure 7, B).

Duet calls involving both the male and female of mated pairs were heard on several occasions. A typical example occurred at nest
2 as follows: both members of the pair were at the nest; the female in
the bowl proper and the male perched on the rim close to the female.
The two then started the duet call; one bird would call in what may be
described as a rapid chering-chering followed immediately by a sharply
rising, metallic bling or bring. The other member of the pair would
then repeat these calls in a similar manner. The calls were repeated
back and forth at intervals of about 20 seconds. This continued for
approximately 12 minutes. The male then mounted the female and
copulation was presumably effected. The male then returned to the
edge of the nest, and with heads held close together the pair resumed
the duet calls for about 10 minutes, whereupon the male flew to a branch
a few feet above the nest and the female resumed interest in arranging
the material about the edge of the nest. This approximate procedure
was observed at two other nest sites with different pairs. At nest 4,
however, portions of the duet before copulation differed from that
observed at nest 2 in that the female occasionally called in a double-
noted bsst, while in answer to this the male uttered a low-intensity,
mellow, double-noted ruk. While the duet calls are performed, both
members of the pair hold the bills somewhat elevated and the crests
and facial feathers fluffed out, giving a large, rounded appearance to
the heads. Barely audible "whisper" calls were heard between mem-
bers of pairs. These "whisper" duets were usually accompanied by
"billing" (reciprocal caressing of the bills).
The Tufted Jays are also quite adept at mimicking. I noted one jay mimicking portions of the song of a Blue Mockingbird (*Melanotis coerulescens*). Immediately after the mockingbird sang, the jay would repeat part of the song. One of my captive jays was able to exactly duplicate various whistles and other similar calls that I made, often after hearing them only once. This captive bird also became quite adept at mimicking the calls of Boat-tailed Grackles (*Cassidix mexicanus*) which were common about the house.
NEST SITE

The nest sites of the individual flocks varied somewhat in the species of trees used, the positions of the nests within these trees, and the height of the nests above ground. Certain generalized requirements were apparent, however, in that all nests were placed in densely foliaged trees in dark, secluded areas made possible by large overshadowing trees. All nests found were in subtropical broadleaf vegetation in barrancas, and often near the heads of barrancas where the soil wash from adjacent ridges formed the initial small flood plain supporting dense thickets and prominent overstory trees. The dense crowns of Clethra lanata seemed to be favored as nest trees; four of the seven active nests noted during the study period in 1964, plus many old nests, were found in this species. The nests in these trees were usually placed high in the densest portions of the crowns. Two active nests found in other less dense trees were placed in thick foliage on horizontal limbs some distance from the trunks. Measured heights from the ground of six active nests ranged from 15 feet to 44 feet, with a mean of 22 feet.

As previously mentioned, nest sites were usually in the immediate vicinity of the areas used for roosting, mid-day rest, and preening sessions. That these sites were favored by the individual
flocks was demonstrated by the fact that old nests were found nearby in every case and in the same tree in two instances. The location of nests in dense branches allows them to remain in situ for some years, and I found many old nests in varying stages of decomposition. Old nests apparently are not refurbished and used again. All active nests observed during the study period were recently built as indicated by the freshly broken twig ends in the lowest portions of the nests.

I have no information concerning how the nest site is selected. One adult female in each flock subsequently lays the eggs and performs all the incubation duties; she also takes far more interest in final placement of nest material and molding of the nest than any other individual. She appears to be the bird most likely to select a suitable site for the nest.
The following accounts describe the construction of three nests by three different flocks and demonstrates the general nestbuilding procedure.

Nest 1

I found this nest in an almost completed state on 24 March 1964. The adult female called a single-note ruk from the nest at intervals of three to four minutes and attracted my attention to it. The flock concerned with this nest was composed of only four individuals, all easily distinguishable from each other. For two days after I discovered the nest, the mated pair and an assumed second-year bird brought material in the form of rootlets and green leaves to the nest. The fourth member of the flock, a first-year bird with completely blue malar patches, was seen going to the nest but was not observed carrying nest material. The active period of nestbuilding during these two days began after the termination of the morning feeding activities (about 10:00 a.m.) and ended shortly after 12:00 noon. During these final two days of nest construction and in the following week, the female spent considerable time on the nest shaping the bowl and rearranging twigs and green leaves about the rim. The other members of the flock
usually perched in nearby trees during these procedures. The first egg was not deposited until 3 April. A nest, which from the condition appeared to be of the previous year, was situated six feet away in the same tree.

Nest 2

I discovered this nest on 29 March 1964 by observing an adult bird fly to it. At this time it was only partially constructed, and it consisted of the bottom platform of large sticks and portions of the side-walls. The flock concerned with this nest was composed of seven individuals: one first-year bird with blue malar patches, and six older birds. As in other flocks, the adult mated pair directly concerned with the nest appeared to be among the oldest birds in the group. An old nest, presumably of the previous year, was situated about 20 feet away in another sapling. During the next few days some material was added to the nest, but I did not observe the construction.

On 2 April the flock interrupted the normal feeding activities to spend approximately 15 minutes shortly after 9:00 a.m. at the nest site, presumably engaged in nestbuilding activity. I was on a cliff some distance above the nest site and could see jays moving to and from the nest area, but I was not near enough to observe actual happenings at the nest. The entire flock then left the nest area and did not return until 11:40 a.m. Then three adults went directly to the nest, scrambling
about the rim in their efforts to retain position. Singly or in groups of two or three, members of the flock began flying to nearby trees to collect twigs and green leaves. Adult birds bringing material to the nest invariably called the nasal aaagh upon approach to the nest, whether or not other individuals were already present. For 22 minutes, one jay after another brought material to the nest and roughly arranged it either on the rim or in the bowl of the nest. After making its contribution, the jay would hop to a nearby branch and watch the next bird place its material. Normally after two or three birds had brought in material, one or more would leave the nest site; but one time I saw five adults arrive singly at the nest site, place material, and then hop to a nearby perch to watch together. The first-year bird was twice observed carrying sticks to the nest, whereupon it would perch on the rim and give low-intensity rak calls while holding the sticks in its bill. Each time, adult birds arrived at the nest with material and more or less shoved the young bird aside. This caused it to drop the sticks and fly to a nearby branch. I know definitely that six individuals (the five seen consecutively plus the first-year bird) aided in the nest construction. I have no reason to doubt that all seven were actively participating.

During the 22-minute period members of the flock made 34 visits to the nest, including the two attempts by the first-year bird. At the end of this period the bird assumed to be the female of the mated pair hopped to the nest and settled into the bowl and began shaping the
nest by thrusting her body forward against the inside wall of the bowl. The bird alternately held its tail vertically and in a flat horizontal position. During the nest shaping procedure, she faced in various directions, stopping at times to rearrange twigs and leaves on the rim of the nest. At intervals she called in a loud single-noted ruk. An imposing adult, which I assumed to be the male of the pair, perched directly over the nest and intently watched the procedure. The other flock members perched in nearby trees and preened themselves during the 11 minutes that the female remained in the nest. None carried nest material during this time, but as soon as the female left the nest to perch with the mate, birds again began to gather material and bring it back to the nest. These activities were carried on sporadically for 48 minutes. The entire flock then left the nest area.

Some nestbuilding activity was carried on after 2 April, especially during mid-day. During these mid-day periods, the female spent much time rearranging the nest material or merely sitting quietly in the nest, while the male usually perched overhead within a few feet of the nest. The remainder of the flock rested in nearby trees. Whenever the flock first entered the nest area, however, some members invariably went directly to the nest, but they would disperse to nearby trees when the female entered the nest.

On 14 April the adult pair was observed copulating on the nest. The first egg was deposited on 19 April.
Nest 4

This nest was discovered in a half-completed stage on 27 April 1964. From 9:05 a.m. to 9:13 a.m. on this date construction was carried on by the flock. The flock then left and it had not returned by 12:30 p.m. when I departed. I saw no birds at the nest site on the several visits I made from the day of discovery until 4 May, although some additional material appeared to have been incorporated. From 4 May through 8 May nest construction was carried on sporadically, and the nest was completed during this time. On 8 May the mated pair copulated on the nest; the first egg was deposited on 10 May. The flock concerned with this nest was composed of 12 individuals, three of which were first-year birds. Since only one of the adults was banded in this flock, it was difficult to ascertain with any degree of certainty how many of the flock participated in nest construction since there was a continual exchange of birds at the nest during material carrying periods. All 12 birds were present about the nest site during rest periods, however, and on the basis of actions of other flocks, I assume all participated since none appeared to be idle during intense periods of construction. First-year birds in this flock were more apt to engage in activities other than nestbuilding. They frequently scolded the observer. The several attempts made by these young birds to bring sticks to the nest invariably ended in failure, as they were pushed out of the way by older birds.
Nestbuilding in the Tufted Jay is a flock enterprise, and even first-year birds participate. Although their contribution to nest construction is probably negligible, it is significant that first-year birds do attempt to help. Since their efforts appear so uncertain, however, perhaps much of the innate ability for nest construction has been lost due to the unusual social behavior of the species. Nest construction is perhaps learned during repeated attempts throughout the prebreeding years. Certain of the "adults" (which may well be second-year birds) in any respective flock do not appear adept at placement of material brought to the nest, and often merely drop their contributions on the nest rim. This material often falls to the ground as other birds scramble in to place material. Thus it follows that even though an abundance of material is brought to the nest, especially in large flocks, much of it is never incorporated into the nest. Hardy (1961:40) noted that the male Blue Jay (Cyanocitta cristata) "...is usually awkward at nestbuilding, and frequently the material that he transports is eventually dropped to the ground." Skutch (1960:238) only once noted a yearling Brown Jay attempting to carry nest material, but he believed that such infrequent nestbuilding activity in young birds may have been due to their greater interest in scolding the nearby observer. First-year Tufted Jays were also much more prone to scold me than were older birds.
Feeding of the young and incubating female by "helpers" other than the male of the pair is commonplace in several species of American Corvidae. However, participation in nestbuilding by members of a flock, other than the pair directly concerned with the nest, occurs less frequently. Gross (1949:242) reported that at least three birds were seen bringing nest material to a nest in the Mexican Jay (Aphelocoma ultramarina arizonae) and that as many as seven or eight birds actually participated in arranging the material. Hardy (1961:36) and Brown (1963a:137), however, state that although all members of a flock in the Mexican Jay seemed to be greatly interested in the nest-building activities, normally only the pair directly concerned with the nest transported most of the material and constructed the nest. In the race Aphelocoma ultramarina couchi in Texas, Van Tyne and Sutton (1937:61) and Brandt (1940) reported that only one pair was ever observed at a nest. In most other corvids in which nestbuilding is known, only the immediate pair participates, and in practically all species the female performs most of the actual placement of material and molding of the nest.

In gathering nest material the Tufted Jays seldom traveled more than 100 yards, and more often less than 50 yards. It was not uncommon to see birds break twigs or leaves from large trees adjacent to the nest tree. Twigs in freshly constructed nests and the fallen material beneath an active nest always showed signs of having been
freshly broken. I never observed birds going to the ground to gather
nest material. Even rootlets used in the lining were broken from
epiphytic plants growing in trees. Gross (1949:243) and Hardy (1961:
36) both noted that the majority of twigs in nests of the Mexican Jay in
Arizona were freshly broken. Skutch (1960:237) also noted that in nest
construction in the Brown Jay, twigs were freshly broken from trees
or vines, and not collected from the ground as is frequently done by
the Blue Jay (Hardy, 1961:41).

False nestbuilding as reported for the Mexican Jay by Gross
(1949:242-6) and for the Blue Jay (Hardy, 1961:27-8) was not observed
in the Tufted Jay. All nests that I observed being built by Tufted Jays
were eventually carried through to termination, and eggs were subse-
quently deposited in them, although at times I believed some nests had
been deserted because of the long periods of inactivity.
NESTS

The completed nests are large, bulky structures, but they are fairly well constructed (Figures 8 and 9). Sticks up to 16 inches in length are incorporated into the outer portions of the nests, and considerably smaller twigs are placed toward the interior. The bowls are compactly woven cups of green vine tendrils and brown or black rootlets. Freshly plucked green leaves are usually displayed about the nest rims, but the number of leaves varies considerably from nest to nest. These leaves appear to be purely decorative in nature. Although the female spends considerable time in arranging them during the nest-building stage, they dry out shortly thereafter and are blown from the nest by wind action.

The position of the nest in the tree somewhat dictates the outer dimensions; nests in dense branches were not as large as those placed in more open situations. The mean outside diameter of three nests found in 1964 was 16 inches (range 13-21) and the mean outside depth was 8.5 inches (range 6-11). The mean inside cup diameter of five nests was 5.5 inches (range 5.2-6.5) and the mean cup depth was 2.5 inches (range 2.0-3.0).
CLUTCH SIZE AND EGG-LAYING

Of a total of six active nests that I found during 1964, three had four eggs each, two had three eggs each and one nest contained two nearly grown young. Moore (1938) found one nest with five eggs and another with five young in the vicinity of Rancho Batel. I received second-hand information on the contents of two other nests found near the study area by local residents. A ranch boy informed me that in early June of 1962 he had climbed a nest tree of the Tufted Jay and four grown young flew from the nest. On 26 May 1963 another boy from this ranch brought me a nearly grown nestling jay. He assured me that there was only one young in the nest and that no infertile eggs were present. Likewise, there were no infertile eggs in the nest which contained two nearly grown young when I found it. I suspect that infertile eggs are either broken or knocked from the nest by the young as they reach maturity. Two eggs which failed to hatch in nest 1 had not been removed seven days after the remainder of the clutch had hatched. I removed and preserved the two eggs at that time. From this information, it appears that normal clutch size ranges from three to five eggs.

Measurements of 19 eggs in millimeters are: length 31.5-38.2, average 34.9; breadth 23.0-25.4, average 23.9. These figures include the measurements of five eggs given by Moore (1938:237) in
his original description of the nest and eggs of the Tufted Jay.

Due to the relative inaccessibility of most of the nests that I found in 1964, I was unable to accurately learn when the eggs are laid. On three occasions I checked the contents of nests late in the evening just before dark and again just after daylight the following day. In all three instances an egg was deposited either during the night or, more likely, in the very early morning. There was no indication from other daily checks on nests that eggs were ever laid in the afternoon. In nests 2 and 4 an egg was laid each consecutive day until the clutch was complete. In nest 1, however, at least a 24-hour period lapsed between the laying of the penultimate and terminal egg.

Since in all cases more than two adults were concerned with each nest, I thought perhaps more than one female might be depositing eggs in a nest. I ruled out this possibility for several reasons. (1) The clutch number was relatively uniform (3 or 4) in all nests which I found in 1964, although the flock size ranged from four to 12, and in the case of the smallest flock of four, the clutch consisted of four eggs. (2) The over-all coloration, shape and size of the eggs varied markedly from nest to nest, but the eggs in each individual clutch were remarkably uniform in regards to these aspects. (3) Finally, in the case of nest 1 where the female was banded, and in other nests where observations were made over extended periods during egg-laying time, only one bird was ever observed sitting in the nest. By uniform clutch
number and prolonged observations, Skutch (1960:254) was able to rule out the possibility of more than one female Brown Jay depositing eggs in a nest. This species has a social nesting behavior similar to the Tufted Jay.

In a nest of the Magpie Jay (Calocitta formosa) that I found in Sinaloa in 1964, seven eggs were in the clutch. The fact that two eggs differed quite markedly from the other five made me strongly suspect that this unusually large clutch was the work of two females. Such cases are usually quite easy to detect, and had more than one female been laying in each nest of the Tufted Jay, I feel reasonably certain that I would have noticed it.
INCUBATION

Prior to egg-laying and incubation the females spend long periods of time quietly sitting in the nest during the day. This behavior differs somewhat from that exhibited during the nestbuilding stage in that during nestbuilding the female devotes much time to shaping the nest by movements of the body or rearranging material. After the nest is completed, however, she spends most of the time quietly sitting, and only rarely engages in rearranging nest material. Hardy (1961:59) terms this behavior "nest-sitting" and states that it may begin as early as the false nestbuilding stage in the female Blue Jay. Skutch (1960:236) notes that "nest-sitting" by the female Brown Jay may begin as soon as the nest site is selected. Scott (1886:82) mentions this behavior in the Mexican Jay.

The Tufted Jay female of nest 1 began sleeping on the nest at least as early as three nights previous to laying of the first egg. In southern Arizona I have found Mexican Jays sleeping on newly constructed, yet empty nests. It seems likely that the females of those species of corvids which engage in "nest-sitting" might also begin to sleep on the nest before egg-laying begins.

"Nest-sitting" probably serves to condition the female for the forthcoming incubation activities, and it may act as a means of saving
energy during the concurrent production of eggs. During 768 minutes of observation in the period of 31 March through 7 April (which included the egg-laying period 3-7 April), the female of nest 1 remained on the nest 64.4% of this time. This did not differ greatly from the following four days of incubation (632 minutes of observation) in which the female remained on the nest 74.6% of the time. The percentage of attentiveness increased as incubation progressed (see Table 2).

During periods of attentiveness on the nest, a female is fed by the other flock members. I first observed the female of nest 1 being fed two days before she laid the first egg. She began prolonged periods of "nest-sitting" at about this time. Probably some feeding occurred before I observed it because the initial feeding seemed already to be a practiced behavioral pattern. Courtship feeding which has been recorded for the Blue Jay (Bent, 1946:34), Scrub Jay (Amadon, 1944b:8) and other corvids was not observed in the Tufted Jay. All courtship behavior between members of pairs, other than pre- and post-copulatory behavior on the nest, consisted of billing and exchange of "whisper" songs.

The rate of feeding of the female by flock members at nest 1 increased markedly through the egg-laying period, and by the end of this time the feeding pattern had been set and did not appear to differ much throughout the incubation period. In this flock of only four birds, the adult male and the two other flock members often remained together during food-carrying excursions to the female. Sometimes all three
Table 2

Summary of attentiveness before and during incubation at Tufted Jay nest 1.

<table>
<thead>
<tr>
<th>Day</th>
<th>Time of day</th>
<th>Total observation time (minutes)</th>
<th>Periods of attentiveness (minutes)</th>
<th>Per cent of total time attentive</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 days prior to egg laying</td>
<td>10:45 a.m. - 1:15 p.m.</td>
<td>150</td>
<td>57, 41</td>
<td>65.3</td>
</tr>
<tr>
<td>2 days prior to egg laying</td>
<td>9:17-10:22 a.m.</td>
<td>65</td>
<td>33</td>
<td>50.8</td>
</tr>
<tr>
<td>1 day prior to egg laying</td>
<td>3:10-4:17 p.m.</td>
<td>67</td>
<td>33, 6</td>
<td>58.2</td>
</tr>
<tr>
<td>1st day of egg laying</td>
<td>7:23-9:06 a.m.</td>
<td>103</td>
<td>26, 43</td>
<td>67.0</td>
</tr>
<tr>
<td>2nd day of egg laying</td>
<td>11:54 a.m. - 12:25 p.m.</td>
<td>31</td>
<td>23</td>
<td>74.2</td>
</tr>
<tr>
<td>Estimated 1st day of incubation</td>
<td>8:22-10:15 a.m. &amp; 4:10-5:24 p.m.</td>
<td>187</td>
<td>43, 38, 33, 25</td>
<td>74.3</td>
</tr>
<tr>
<td>2nd day of incubation</td>
<td>8:30-10:12 a.m.</td>
<td>102</td>
<td>8, 47</td>
<td>53.9</td>
</tr>
<tr>
<td>3rd day of incubation</td>
<td>11:09 a.m. - 12:15 p.m.</td>
<td>63</td>
<td>36, 9</td>
<td>71.4</td>
</tr>
<tr>
<td>4th day of incubation</td>
<td>1:15-3:22 p.m.</td>
<td>127</td>
<td>42, 37, 19</td>
<td>77.2</td>
</tr>
<tr>
<td>5th day of incubation</td>
<td>7:21-9:12 a.m. &amp; 12:34-1:56 p.m.</td>
<td>193</td>
<td>34, 57, 51, 13</td>
<td>80.3</td>
</tr>
<tr>
<td>6th day of incubation</td>
<td>8:30 a.m. - 12:08 p.m.</td>
<td>218</td>
<td>30, 54, 42</td>
<td>57.8</td>
</tr>
<tr>
<td>7th day of incubation</td>
<td>8:10-9:44 a.m.</td>
<td>94</td>
<td>42, 36</td>
<td>83.0</td>
</tr>
</tbody>
</table>
Table 2 (continued)

<table>
<thead>
<tr>
<th>Day</th>
<th>Time of day</th>
<th>Total observation time (minutes)</th>
<th>Periods of attentiveness (minutes)</th>
<th>Per cent of total time attentive</th>
</tr>
</thead>
<tbody>
<tr>
<td>8th day of incubation</td>
<td>12:22-3:15 p.m.</td>
<td>173</td>
<td>48, 57, 37</td>
<td>82.1</td>
</tr>
<tr>
<td>10th day of incubation</td>
<td>10:24-11:46 a.m.</td>
<td>82</td>
<td>39, 34</td>
<td>89.0</td>
</tr>
<tr>
<td>11th day of incubation</td>
<td>8:12-10:02 a.m.</td>
<td>110</td>
<td>43, 48</td>
<td>82.7</td>
</tr>
<tr>
<td>14th day of incubation</td>
<td>7:28-9:45 a.m. &amp; 4:10-4:50 p.m.</td>
<td>177</td>
<td>32, 52, 31, 40</td>
<td>87.6</td>
</tr>
<tr>
<td>15th day of incubation</td>
<td>3:26-4:48 p.m.</td>
<td>83</td>
<td>55, 21</td>
<td>91.6</td>
</tr>
<tr>
<td>16th day of incubation</td>
<td>9:05-10:15 a.m.</td>
<td>70</td>
<td>43, 16</td>
<td>84.3</td>
</tr>
<tr>
<td>17th day of incubation</td>
<td>1:05-4:48 p.m.</td>
<td>223</td>
<td>52, 56, 58, 39</td>
<td>91.5</td>
</tr>
<tr>
<td>18th (final) day of incubation</td>
<td>7:24-9:45 a.m. &amp; 3:15-4:45 p.m.</td>
<td>231</td>
<td>48, 42, 56, 72</td>
<td>94.4</td>
</tr>
</tbody>
</table>

Average percent of time attentive during incubation period (42.5 hours of observation) = 80.1%.
would bring food in and feed the female, but usually only one or two would actually carry food. At times the male remained perched above the nest while the other two brought food to the female or sought food for themselves. Males in other flocks also spent considerable time perched above their incubating mates while the other flock members were engaged in feeding or food-carrying excursions. In larger flocks there was a tendency for some breakup of the flock during food-carrying activity. This was more apparent during late stages of incubation and after the young had hatched.

The begging call was usually given by the female when another flock member approached the nest. When accepting food from another bird, the female would usually quiver her wings slightly and partially rise up from the nest. The female always made a gurgling sound when swallowing food which I was unable to distinguish from that made by large nestlings during this procedure.

I only once observed the female of any flock being fed away from the nest. This occurred at nest 3 where a first-year bird brought food to the female as she perched with her mate approximately 30 yards from the nest containing fresh eggs.

From daybreak to about 9:00 a.m., the flock members of nest 1 averaged about one trip every 50 minutes to bring food to the incubating female. The amount of food actually fed to the female depended upon the quantity carried by flock members and the number of these
which brought food. At about 9:00 a.m. the female would usually leave
the nest area accompanied by the other three. Perhaps the departure
was correlated with rising air temperatures so that the eggs would not
be seriously cooled. The female normally stayed away from the nest
during these mid-morning trips from 20 to 25 minutes, but on the
morning of 10 April she left at 9:00 a.m. and did not return until 10:30
a.m. This was the longest period of absence from the eggs that I
noted for any incubating bird. The female usually returned to the nest
alone. Invariably she went directly to the nest and scarcely paused at
the rim before she settled down to incubate. Her returns to the nest
were usually heralded by a series of loud rak calls, but once at the
nest she remained quiet. Several times while observing other flocks
feeding, I saw a single bird leave the flock and fly in the direction of a
nest, calling in such a manner as it progressed in typical short flights.
I presumed that these single birds were probably females returning to
their nests to incubate.

Absences from the nest by the female at some time during the
mid-morning appeared to be customary in all flocks. I doubt that the
female left the nest to feed since the flock members appeared to bring
more than enough food to her. In flock 3 (12 individuals), for example,
birds in groups of from four to six would often come in at the rate of
one group every 15 to 20 minutes during the morning hours previous to
the female's departure. In these cases, three or more might fly to the
nest upon arriving. The female invariably responded by giving the begging call, quivering her wings, and slightly rising from the eggs. After one bird had fed her, she usually settled back onto the nest immediately and exhibited no further begging display. The other birds present, often with food visible in their bills, were not stimulated to feed her in the absence of such display. Invariably they left the nest area, though they sometimes paused to gulp the food they had brought. Skutch (1960:259) found that an incubating female Magpie Jay was fed so much by her mate and other flock members that she found it unnecessary to forage.

During the female's periods of inattentiveness, the nest was usually left unguarded. Several times, however, when I attempted to climb nest trees after the female had left with the flock, she quickly returned to the nest, protesting loudly. Obviously, at such times she had been within sight of the nest tree. On such occasions she usually went directly to the nest after I had descended from the tree, and would begin to incubate. Skutch (1960:239) states that the male Brown Jay usually remained on guard at the nest during a female's absence. As already noted, male Tufted Jays often spent long periods over the nest, but this normally occurred only while the female incubated.

Only the female Tufted Jay was observed to incubate. Although it was common practice for other flock members to go to the nest, none were ever observed incubating. During early stages of incubation, the mated female of a flock often left the nest to perch a few minutes with
her mate after being fed. It was at such times that other flock members often flew to the nest to peer at the contents. The time spent at the nest by flock members during these visits was invariably only a few seconds. Flock members other than the female usually gave the *aaagh* call when approaching and leaving the nest. The adult mated pair directly concerned with the nest never appeared to resent these visits to the nest by other flock members. Moore (1938:238) observed another Tufted Jay squeeze into the nest with the incubating female for about three minutes. This was probably the male of the pair exhibiting a continuation of copulatory behavior since all instances of copulation that I observed took place on the nest, and both members of a pair often remained in the nest for some time.

The lapsed time between the laying and the hatching of the last egg (Nice, 1954:173) appears to be the most accepted definition of the incubation period. I was able to apply this criterion only on nest 4, in which the last egg hatched in 18 days. The penultimate egg also hatched on the same day whereas the first and second eggs of the clutch of four hatched on the preceding day. According to Skutch (1960:262) many of the corvids apparently begin incubation with the laying of the first egg rather than with the laying of the last egg as in many other passerine birds. Apparently the Tufted Jay starts incubating some time after the second or third egg is laid (see Table 3). Only the second and third eggs hatched out of the clutch of four in nest 1. In this case both eggs
Table 3

Egg-laying and hatching dates in two nests of *C. dickeyi.*

<table>
<thead>
<tr>
<th>Egg</th>
<th>Date of laying</th>
<th>Date of incubation probably began</th>
<th>Date of hatching</th>
<th>Days from laying to hatching</th>
<th>Incubation period</th>
</tr>
</thead>
<tbody>
<tr>
<td>1*</td>
<td>3 April</td>
<td>5 April</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>2</td>
<td>4 April</td>
<td>5 April</td>
<td>23 April</td>
<td>19</td>
<td>18</td>
</tr>
<tr>
<td>3</td>
<td>5 April</td>
<td>5 April</td>
<td>23 April</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>4*</td>
<td>7 April</td>
<td>7 April</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

Nest 4

<table>
<thead>
<tr>
<th>Egg</th>
<th>Date of laying</th>
<th>Date of hatching</th>
<th>Days from laying to hatching</th>
<th>Incubation period</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10 May</td>
<td>12 May</td>
<td>30 May</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>11 May</td>
<td>12 May</td>
<td>30 May</td>
<td>19</td>
</tr>
<tr>
<td>3</td>
<td>12 May</td>
<td>12 May</td>
<td>31 May</td>
<td>19</td>
</tr>
<tr>
<td>4</td>
<td>13 May</td>
<td>13 May</td>
<td>31 May</td>
<td>18</td>
</tr>
</tbody>
</table>

*Egg did not hatch.
hatched 18 days after the laying of the third egg. The sequence in hatching of the eggs in nest 4 also suggests that incubation probably begins shortly after the second or third egg is laid.
FEEDING AND CARE OF THE YOUNG

Nest 1

A periodic check late in the afternoon of 22 April at nest 1 showed that egg 2 was pipped. At 9:50 a.m. the following day, egg 2 had hatched and egg 3 had portions of the shell chipped away so that the head region of the young bird could be seen. In both instances the banded female was on the nest when I arrived. Egg 3 finished hatching by 12:20 p.m. On previous checks on the nest, the female had usually left the nest when I began to climb the tree, but on the day of hatching, she remained on the nest until I was within a few feet of it on each of the two occasions. Her calls, consisting of series of loud raks, brought the other members of the flock protesting to the nest site in both instances. All birds seemed to be more concerned than usual and the female approached to within three feet of me while I was at the nest. Normally, the first-year bird was the individual demonstrating the bravest advances when I climbed to the nest.

The young at hatching are naked and without a trace of down, and the eyes are completely closed. The bodies are dark pink with a yellowish tinge. This latter color is more pronounced at the corners of the mouth, eye region and feet.
During 155 minutes of observation throughout the morning of hatching, the female brooded almost constantly. Three times during this period of observation she hopped to the edge of the nest, turned and perched low on the rim, and poked into the nest. I assumed that she was feeding the young bird which had already hatched or possibly aiding the second bird in hatching. She must have eaten the pieces of shell from egg 3 since all traces, save a few small fragments, had disappeared from the nest when I viewed it at 12:20 p.m. After each of my trips up the tree, she returned to the nest less than a minute after I had reached the ground.

Twice during the observation period the other three flock members came in as a group to feed the female on the nest. At the first visit, both the adult male and the first-year bird fed her, whereas on the second appearance she was fed by the first-year bird and the assumed second-year bird. The adult male participated in the second visit but did not bring food.

On the second day of the altricial period I observed the nest from 2:15 to 3:00 p.m. The female was brooding when I first entered the nest area and scolded vigorously in her excited rak calls when I climbed the tree to check the young. The rest of the flock did not appear at this time. Eggs 1 and 4 had not hatched (they did not show evidence of fertility when I removed them from the nest and prepared them a week later). At 2:27 p.m. the female moved to the edge of the
nest and fed the young with regurgitated food. She remained perched on the edge of the nest for about 20 seconds and then probed into the bowl with her bill and picked up either particles of dropped food or fecal sacs and swallowed them. She then settled into the nest and brooded until 2:42 p.m. when the other flock members entered the nest area. Both the first- and second-year birds went immediately to the nest and fed the female. The two helpers then left the nest area and almost immediately the male flew to the nest and fed the begging female with food that he had retained in his throat. The male then flew to a perch a few feet above the nest and the female returned to brooding. At 2:53 p.m. the female hopped to the edge of the nest and again fed the nestlings. The male became obviously excited during this procedure and flew to the nest. At his approach the female stopped feeding the young and began to beg. She continued begging off and on for nearly a minute. The male once went through the motions of feeding her, but I did not see her receive any food. Finally the female settled back on the nest, but for some minutes she occasionally showed weak begging activity by slightly quivering her wings and calling in a subdued aaagh note. When I left the nest area at 3:00 p.m. the male was still perched on the rim of the nest.

In the afternoon of the third day of the altricial period I saw the male feeding the young, and after this date both helpers as well as the male were observed to feed them. However, during the first week,
practically all food brought to the nest by the male and the two helpers was given to the female and she in turn fed the young periodically. After the third day the female usually hopped to the edge of the nest when her mate or other helpers came to the nest with food. Although she continued her begging behavior, the sight of the open-mouthed nestlings probably stimulated the other members to feed them. After the first week of the altricial period the female began to spend short periods of up to 20 minutes perched above the nest. No other birds were observed to brood the young during these times. On the eighth day the female joined the other flock members in food-carrying excursions to a fruiting magnolia tree approximately 50 yards from the nest. During 95 minutes of observation from 8:40 to 10:15 a.m. on this morning, food was brought to the nestlings 14 times by the four adults. On at least four of these visits, the young apparently did not desire food. The first-year bird seemed particularly undecided when the young birds did not respond with begging posture. On one occasion it carried a large billfull of ripe magnolia pulp back and forth three times between the nest and a branch about six feet distant. During this procedure it called alternately the low-intensity rak notes and the typical aaagh call each time it hopped to the nest. Finally it flew back to the magnolia tree where the other members were apparently engaged in feeding. The time intervals between visits to the nest with food by the adults often appeared to be directly correlated with the amount of food
available and the distance of the food from the nest rather than some set number of feedings over a period of time. Sometimes joint visits to the nest with food by the three adults averaged less than once per hour.

Development of the young Tufted Jays is rather slow. At five days of age their eyes are still closed, and they are still completely naked. There is a slight indication of internal development of the remiges and rectrices by this time. This area becomes darker during the following few days and slight protuberances appear. By the eighth day these young feathers are pronounced, but are still encased in the feather sheaths. The eyes at this time are just beginning to open and appear a dull blue-grey color. By the 12th day, secondaries begin to break through the sheaths, but most remiges and rectrices do not break their sheaths until the 14th day. By this time the eyes are fully open and fluffy juvenal feathers become pronounced on most tracts of the trunk region; the various feather regions of the head show slower development. The neck region still has a sparse covering of feathers at this time. This is especially obvious when the neck is stretched when the birds are begging food. By the 18th day the young appear practically covered with feathers when in a crouching position in the nest. However, if the birds are lifted from the nest, large bare areas between the ventral and spinal tracts are obvious. The feathers over the crural and abdominal regions are little developed and bare.
areas are pronounced on the undersides of the wings.

By the age of two weeks the young can grasp powerfully with their feet. Only by sliding my hand gently under them and allowing them to creep onto it could I lift them from the nest. Otherwise, they would cling so tightly to the nest lining that there was danger of hurting them if I tried lifting them directly out of the nest.

The young of nest 1 disappeared from the nest 19 days after hatching. At this stage, although now quite well feathered, they were still too young to fly. Either they were frightened from the nest or captured in it by some predator. The only obvious predators in the area were the Cooper's Hawk (Accipiter cooperi) and Grey Fox (Urocyon cinereoargenteus). After observing the four adult members of the flock for a few hours, it was quite obvious that the young were indeed gone and not hiding somewhere in the dense underbrush.

Nest 6

I discovered another nest containing two nestlings at the extreme western limit of the study area on 14 May. Upon comparing their development with those of nest 1, I judged these young to be about 20 or 21 days of age. The flock concerned with this nest was composed of seven individuals. The bird which I judged by her actions to be the parent female remained about the nest area most of the four-and-a-half hours that I observed the young on the day of discovery. Possibly my
presence prompted her to remain near the young more than she normally would have (the female of nest 1 often left the nest area with the other flock members after the young were fairly well feathered, i.e., about 16 days of age). The female of this flock of seven usually flew to a point near the nest when any of the other flock members came in with food. She exhibited begging behavior whenever a flock member came near her, especially if visible food was being carried by the helper. I saw her being fed only three times during the entire observation period, whereas the two young birds were fed 32 times during this period. I was able to identify very little of the food brought to the young because in the majority of cases the adult birds retained it in their throats and transferred it directly to the gaping mouths of the nestlings. Occasionally I observed several helpers bringing in large green katydids and pulpy fruit, probably of the magnolia.

The nestlings spent most of their time perched on the edge of the nest. Several times one or another maneuvered some distance out on a limb which protruded from beneath the nest. They spent a great deal of their time preening. They often stretched to the fullest extent of their legs. When the female ventured near them after they had been fed by the other flock members, one, or sometimes both young, would lower the head and completely raise the feathers of the nape and crown. The female usually performed at least some preening on the young when they postured in such a manner.
Since this nest was located approximately six hours walk from my camp, it was not feasible to attempt to return. I stayed at a nearby ranch the first night and took the young birds back to my camp the next day.

Young Tufted Jays adapt quickly to captivity. The young learned to eat by themselves within a few days after I had taken them from the nest (at an estimated 27 days of age). They were allowed to roam freely about the camp and soon were able to make short flights into nearby trees, coming down when they desired to be fed. They were completely omnivorous, but preferred fresh meat and boiled eggs.

Between feedings the young spend a great amount of time preening. They nearly always raised their nape feathers and lowered their heads to be preened whenever I approached (unless they desired to be fed). Even wild birds, approaching one year of age, persistently pose in this position before older birds and often hop from branch to branch after an adult in their desire to be preened. The first-year bird of flock 1 often posed to a member of the adult pair, and occasionally one of the adults would preen it.

Young captive birds enjoyed bathing and would do so at least once daily if the water was offered them. After bathing they would spend up to an hour carefully preening the entire feather coat. This urge to bathe was less pronounced as the birds grew older and after six months of age, captive birds seldom bathed. I never observed a
bird in the wild attempting to bathe. At times I observed flocks for hours in the heat of the day with water in view, and I never noted a bird taking the slightest interest in bathing or drinking.

The young jays possess a high degree of curiosity and must peck at every object in sight. Portions of excess food and miscellaneous small objects are usually poked into any handy cavity capable of holding them. This appeared to be a one-way procedure, however, since the birds never tried to retrieve these objects once they hid them. I did not observe birds in the wild displaying this behavior.

In the evening when the birds were about to roost, they made every attempt to reach the highest perch within their view. This apparently is an innate behavioral pattern and is probably greatly beneficial to young birds in the wild, in that they undoubtedly roost at considerable heights in trees and therefore are out of reach of most predators that hunt on or near the ground.

Through my observations of the development of the young in the nest and by study of their actions during the early days of captivity, I conclude that the young probably leave the nest at about 24 days of age. Undoubtedly they are cared for by the flock members for some time after this. Since each flock that was encountered in 1964 had from one to four first-year birds, it appears that any young which are raised become an integral part of their respective flock.
DISCUSSION AND CONCLUSIONS

The Tufted Jay is a highly social species and individual flocks maintain themselves as units throughout the breeding season and probably throughout the year. Only one pair mates in any respective flock. All other members of the flock help to build the nest, feed the incubating female and later the nestlings. Skutch (1954, 1960) cites many examples of helpers at the nest in the families Paridae, Troglodytidae, Turdidae, Thraupidae and others, but in the majority of these cases this behavior is not consistent for all members of any given species. Several species such as the Magpie Jay, Brown Jay and Mexican Jay do consistently exhibit social nesting behavior. Among these, the Brown Jay demonstrates social flock behavior during nesting which closely approaches that of the Tufted Jay (Skutch, 1960).

Throughout the entire nesting cycle, all members of a Tufted Jay flock work toward the success of the single nest. Examination of the gonads of Tufted Jays collected during the breeding season shows enlargement of the reproductive organs in all members of the flock except first-year birds. Apparently these older birds which do not mate are physiologically capable of breeding but do not because some drive diverts them into attending the nest of the sole pair which mates (quite likely the top pair in the hierarchy of each flock). This highly
social behavior may possibly exist in other species of the genus *Cyanocorax*, since it is evident in two closely related genera—*Calocitta* and *Psilorhinus*.

The Steller's Jay is the only other member of the subfamily *Garrulinae* occupying the immediate geographic range of the Tufted Jay. They occupy separate niches in regards to feeding and nesting and apparently do not compete to any extent. Although the behavioral relationships between these two species are unclear, it is apparent that the larger Tufted Jay is dominant over the Steller's Jay. Brown (1963b: 483) found that the Scrub Jay (*Aphelocoma coerulescens*) was invariably dominant over the Steller's Jay in a behavioral study made in California. The Steller's Jay, because of its smaller size, is probably dominated by many species of jays within its range, such as the Scrub, Mexican, Tufted and Unicolored (*Aphelocoma unicolor*). Despite this, it is unquestionably highly successful, and ranges from southern Alaska to Nicaragua. Within this vast range it must of necessity be very plastic in regards to food, nesting and climate. The Tufted Jay, on the other hand, appears to be quite specialized in these respects. The Tufted Jay apparently is restricted to and depends upon the barranca habitat for both its feeding and nesting activities. Within its limited range, it is not a common bird.

Even if flock cooperation insures a better chance of survival of the young than does rearing by a single individual or a pair, I
believe that the Tufted Jay's highly specialized breeding behavior results in the expenditure of too many birds for the purpose of raising a single brood. Tufted Jays are not presently found in the immediate vicinity of Rancho Batel where they were once common. This is undoubtedly the result of concentrated collecting. However, the habitat has not changed, and apparently reproductive capacity in the surrounding area is not great enough to repopulate this site.

I suggest that birds such as the Tufted Jay, Quetzal (Pharomachrus mocino) and Imperial Woodpecker (Campephilus imperialis) be excluded from collecting and placed on a special protection list on Mexican federal collecting permits. I fully realize that destruction of habitat and not selective collecting is responsible for the extermination of most species. However, when a large conspicuous species is drastically reduced in numbers, even selective collecting can be disastrous. The Tufted Jay is not in danger from local hunting because the residents in the bird's range do not consider it as a food source. Nor is its habitat in any immediate danger of being destroyed. On the other hand, I can think of no reason for further collecting of this species, with the possible exception of a small sample to determine its winter diet. A much more fruitful investigation would be a three or more year study of banded birds to determine the composition of flocks in regard to the relationships of their members, definite ages of the
individuals, and the composition of the hierarchy which must logically exist in so highly social a species.

The Tufted Jay clearly appears to be a relict species presently occupying a limited range in western Mexico. Although distantly separated spatially from very similar species of *Cyanocorax* in South America, it unquestionably is closely related to these forms, of which *Cyanocorax mystacalis* is most similar. Amadon (1944a:9-10) thinks that this striking similarity may be a case of parallelism, but further suggests, however, that "... *Calocitta* has perhaps replaced more primitive earlier Mexican species of the former *Cyanocorax*." In this respect I would add *Psilorhinus* as perhaps being operative in replacing earlier forms of *Cyanocorax*. The Tufted Jay may still be in serious competition with the Magpie Jay in the lower altitudinal limits of the former's range. I have never had the occasion to see the two species in contact with one another, but I have been in localities on the western slope of the Sierra Madre in Sinaloa where both species were seen on separate occasions. I think it highly significant that the ranges of the two border each other, yet apparently do not overlap to any extent.

Amadon's (1944a:8) "Coronideus" group consisting of *Cyanocorax caeruleus*, *C. cyanomelus*, and *C. violaceus* certainly tend more toward *Psilorhinus* than they do toward *C. dickeyi* or *C. mystacalis* and probably gave rise to *Psilorhinus*. *Calocitta* quite likely is an offshoot of some form such as *Cyanocorax* (=*Uroleuca*) cristatella. That
Psilorhinus and Calocitta have close relationship is demonstrated by the fact that they are known to hybridize in one of the few areas of overlap (Pitelka et al., 1956:98-106). Instances of two drastically different morphologic forms having close relationship is demonstrated by hybridization in the towhees, Pipilo erythrophthalmus and ocai on the Mexican plateau and in lesser degree by the buntings (Passerina) and flickers (Colaptes) in the United States.

The Green Jay (Cyanocorax yncas) apparently represents yet a third line of descent from basic South American Cyanocorax. I think it significant that it shows the greatest degree of morphologic divergence from these forms in certain of its geographically most remote races such as luxosa which extends into southern Texas.

I consider C. dickeyi and mystacalis to represent primitive Cyanocorax stock which, although now separated by approximately 3000 miles, probably ranged continuously through Mexico and Central America or were represented in this intervening area by similar forms. This intervening region has been taken over and is now occupied by more recently evolved forms such as Psilorhinus and Calocitta. Dickeyi is apparently the northernmost relict species representing a former far-ranging, predominantly tropical lineage of jays. In accordance with this, it should be noted that its habitat is not strictly montane pine-oak as Moore (1935:274) and Blake (1935:378) imply. Although its habitat is surrounded by and includes montane elements,
the important aspects of the breeding cycle and feeding are dependent upon the barranca areas which support an abundance of tropical vegetation and a number of essentially subtropical to tropical avian species such as *Ortalis wagleri*, *Penelope purpurascens*, *Tityra semifasciata*, *Euthlypis lachrymosa*, *Pachyramphus major* and others.
LITERATURE CITED

Amadon, D.


Bent, A. C.

Blake, E. R.

Brandt, H.
1940 Texas bird adventures. Bird Research Found., Cleveland, xii + 192 pp., frontispiece, 16 pls.

Brown, J. L.

1963b Aggressiveness, dominance and social organization in the Steller Jay. Condor, 65:460-484, 6 figs., 7 tables.

Gentry, H. S.


Gross, A. O.
Hardy, J. W.

Miller, A. H., H. Friedmann, L. Griscom, and R. T. Moore

Moore, R. T.
1938 Discovery of the nest and eggs of the Tufted Jay. Condor, 40:233-241, 4 figs.

Nice, M. M.

Pitelka, F. A.

Pitelka, F. A., R. K. Selander, and Miguel Alvarez Del Toro
1956 A hybrid jay from Chiapas, Mexico. Condor, 58:98-106, 5 figs., 1 table.

Scott, W. E. D.
1886 On the breeding habits of some Arizona birds. Auk, 3:81-86.

Shreve, F.

Skutch, A. F.
1960 Life histories of Central American birds. Part 2. Families Vireonidae through Tyrannidae. Pacific Coast Avifauna, No. 34, 593 pp., 100 figs., 8 tables, 1 pl.
Swanberg, P. O.

Van Tyne, J., and G. M. Sutton