HABITAT AND HABITS OF THE DWARF JAY, *APHELOCOMA NANA*

JOHN WILLIAM HARDY

IN a paper discussing behavior, habitat, and relationships of jays of the genus *Cyanolyca* (which I now regard as a subgenus of *Aphelocoma*, Hardy, 1969:371, as here used), I briefly described (Hardy, 1964:8–11) the vegetation inhabited by Mexican species of this group. I referred (p. 10) to the habitat of the Dwarf Jay (*A. nana*) as . . . "humid pine-oak forests. . . . from nearly pure stands of oak, containing only scattered pines (*Pinus*) and an understory of subdominant broad-leaved trees, to forests of nearly equal pine and oak representation, scattered fir (*Abies religiosa*), and abundant epiphytic growth."

From 1 March to 21 April 1965, 24 April to 4 May 1966, and 6 to 16 May 1967, I studied these habitats and also the habits and niche characteristics of the Dwarf Jay on Cerro San Felipe, 3 to 5 km NW of La Cumbre and about 30 km NE of the city of Oaxaca, state of Oaxaca, Mexico, long. 96° 60′ W, lat. 17° 20′ E. The results are the subject of the present paper.

METHODS

Analysis of Vegetation.—I used quadrats each 100 sq. meters in area, in analyzing the forest. Square quadrats were employed in the more mature, open, sparsely wooded communities, as belts of one to two meters width fail in such a habitat to record positional relationships and even occurrence of widely spaced, very large trees. Quadrats 50 × 2 m were used in densely vegetated stands containing more prominent second and first story trees, rather uniformly spaced under sparse mature trees, usually forming a much broken third story or canopy. Seven forest locations were studied. Five areas (Hillside quadrats 1, 3, 4, of 1965; 1, 2, of 1966) were in nesting habitat of Dwarf Jays and either contained active nests or were near nests (quadrat 4). Hillside quadrat 2, 1965 was on an exposed slope in foraging habitat not known or thought to contain Dwarf Jay nests. Hillside quadrat 5 was in open mature pine forest seldom visited by Dwarf Jays, but a vegetational community interspersed intimately with jay habitat communities. Two deep canyon (=barranca) quadrats were in climax *Meliosma* forest regularly visited by jays in wide-ranging foraging activities in afternoon hours. Communities consisting of scattered groups of large firs with a dense understory of small oaks were not analyzed, although these were foraged in by jays moving between upland nesting and foraging areas and barrancas.

In the field analysis, I delimited with a rope an area to be censused. Trees within were then mapped as to position, species, diameter at breast height (DBH, diameter at a height of 1.35 m), and crown position. The main foliage cluster of a tree, or its crown, was thus designated as contributing either to the forest canopy (third level), subcanopy (second-layer), sapling (first level), or shrub-seedling (ground cover level). The shrub-seedling level was sparse in most communities, and I adjudged it to be

Dwarf Jay (*Aphelocoma nana*) ¾ X. Watercolor by George Miksch Sutton.

insignificant in the ecology of jay habitat. I ignored it except for tree species found to be constituents of one of the other levels.

I estimated degree of slope, exposure, and elevation, and collected epiphytic growth, leaf, twig, and fruit specimens for later identification.

Study of Jays.—My assistants and I located and observed activities at nests from within blinds and also without blinds. Nest contents were checked periodically using a mirror mounted on a long pole. We took notes on time spent foraging by the birds in different vegetation and at different levels in the forest. Recordings of vocalizations were made using sound equipment described by Hardy and Dickerman (1965:110). I observed feeding habits and preserved stomach contents. Specimens of jays were collected, to determine change and status of reproductive condition of apparently nesting jays not specifically under study and of apparently non-breeding, flocking individuals. Abandoned nests and eggs were preserved. A general collection of birds, mammals, and plants was made. Rainfall was measured using a standard rainfall gauge situated in the open. A hygrothermograph recorded temperature and humidity during this period near ground level in the forest.

VEGETATION AND THE JAY NICHE

The mountain forests of Oaxaca in which the Dwarf Jay lives have suffered greatly from deforestation, small farm agriculture, and other pressures of human activity. Where disturbance has been especially severe, the basic character of the vegetation is so completely altered that only remnant components of the original avifauna not including the jay persist. Dwarf Jays, in fact, seem to exist only where most of the forest is of climax tree species. The birds are not restricted to the undisturbed areas, however, frequently being common in second growth climax, so long as the climax species of trees predominate, and tracts of mature climax forest are nearby. Oaks (*Quercus* spp.), pines, and fir are the dominant trees in the jay habitat (Tables 1 to 3). These occur in various associations and faciations. On the drier slopes, either southern or western exposure or near the crests of ridges above 6000 feet elevation (Tables 1 and 2), a *Q. rugosa—Q. laurina* association prevails (Fig. 1), with fir and pine as scattered components of the layers below the canopy. *Q. rugosa* is a heavy rugged tree with broad, rough, and coriaceous leaves. *Q. laurina* is a "willow oak" type of tree with small, slender, thin leaves. Firs in this association are small and scattered, pines are rare and various in size, and other tree species are usually represented by isolated individuals of various size or absent. Hillside quadrats 1 to 4, 1965 (Table 1) are of this association. An active Dwarf Jay nest was in or near each of these quadrats except quadrat 2. All except quadrat 2 were in second growth woodland. Of the three associations in which Dwarf Jays consistently occurred, they were sparsest in this one, according to my observations. Following is a brief description of the character of the vegetation in each quadrat area, to supplement quantitative data in the tables.

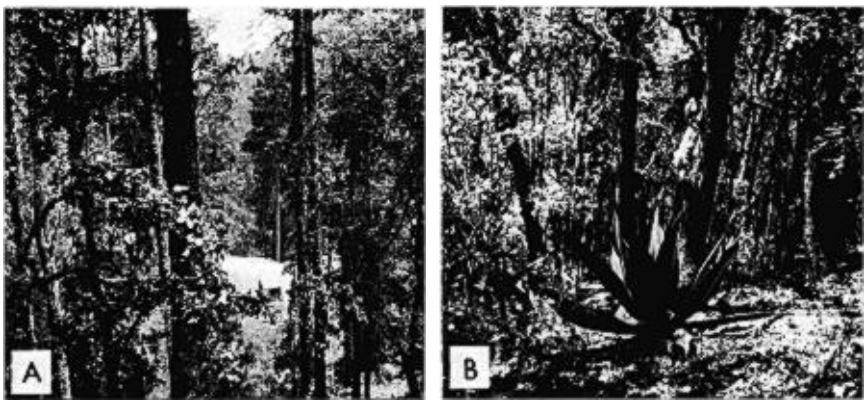

FIG. 1. Woodland communities of Cerro San Felipe, Oaxaca, in the Dwarf Jay study area. A. Dense second-growth climax humid oak woods near site of nest 1, 1965 (see Table 1, quadrat 1). B. Mature humid oak climax forest from near site of nest 3, 1965; camp in lower background (see Table 2, quadrat 4).

Hillside quadrat 1, 1965. Exposure NW, slope 45 degrees. Canopy sparse, 12–23 m high, secondary level dense, between 6 and 11 m high. First story, fairly dense merging with second story, 1.5 to 6 m. Heavy leaf litter, but little ground vegetation of herbaceous type. Heavy epiphytic growth of usnea, moss, lichens, and ferns. Large trees as evidenced by stumps have been cut. One of these, an oak, had been 850 mm in diameter. Several others nearly that size also present.

Hillside quadrat 2, 1965. Exposure WNW, slope 45 degrees. Similar to number one, but subcanopy more open, probably too open to be suitable for Dwarf Jay nesting.

Hillside quadrat 3, 1965. Exposure SE, slope variable, 30–45 degrees. Irregularly disturbed woodland, about 270 m across clearing from 1 and 2. More mature trees of the dominant species than in preceding quadrats. Canopy trees 23 to 38 m in height. Drier ground aspect with considerable litter of pine needles. Greater variety of tree species in understories.

Hillside quadrat 4, 1965. Exposure E, slope 60 degrees. Few stumps of large trees, so that canopy is the crown of the secondary layer, which is so dense (approximately 50 per cent closure) that ground level is deeply shaded. Very sparse ground cover; leaf litter mostly pine needles.

Jays were so sparsely distributed in the preceding four quadrat areas that each of four pairs discovered nesting in such communities were, so far as I could detect, completely free of other jays wandering into their areas, boundary disputes, or even the voices of other individual jays.

Jays seemed to be more abundant in oak-fir-pine associations as exemplified by quadrats 1 and 2, 1966 (Table 2), taken on northeast and east exposures and slopes of 10 to 20 degrees at approximately 2800 m elevation. As an indication of the greater density of birds, an observer could frequently hear other jays calling as he watched activities at nests near these

TABLE 1

VEGETATIONAL COMPOSITION OF QUADRATS 1–5, 1965 OF THE DWARF JAY STUDY AREA*

Tree Species	No.	(%)	Per cent trees in veg. levels 3	2	1	Gr.	Total DBH	B.A. Ha.	%B.A.
(Hillside Quadrat 1, 50 × 2 m)									
Quercus rugosa	9	(21)	75	33	12	—	1095	78.5	28.0
Q. laurina	30	(69)	25	67	>81	50	1686	201.0	71.0
Abies religiosa	2	(5)	—	—	> 8	—	15	0.02	Trace
Arbutus xalapensis	2	(5)	—	—	—	50	160	2.0	>1.0
(Hillside Quadrat 2, 10 m²)									
Quercus rugosa	5	(29)	40	—	20	40	970	62.8	22.0
Q. laurina	10	(59)	30	50	—	20	1710	219.0	77.0
Arbutus xalapensis	2	(12)	—	50	—	50	155	2.0	1.0
(Hillside Quadrat 3, 10 m²)									
Quercus rugosa	14	(27)	14	7	64	7	2057	314.0	68.0
Q. laurina	11	(22)	9	27	64	—	770	50.0	>11.0
Arbutus xalapensis	1	(0.5)	—	100	—	—	260	4.0	0.86
Litsea galacescens	11	(22)	—	27	73	—	385	12.5	2.8
Pinus tenuifolia	8	(16)	—	75	25	—	950	78.5	17.0
Jatropha sp., *Montanoa arborescens*, *Abies religiosa*	6	(3)	—	33	50	17	295	1.04	>0.003
(Hillside Quadrat 4, 10 m²)									
Quercus rugosa	7	(26)	—	57	29	14	590	28.3	5.6
Q. laurina	11	(41)	18	73	9	—	2140	452.0	89.4
Pinus sp.	3	(11)	33	—	33	33	460	15.7	3.1
Abies religiosa	3	(11)	33	—	33	33	305	6.3	1.2
Unidentified tree	3	(0.1)	—	33	67	—	225	3.1	0.06
(Open Pine Stand Hillside Quadrat 5, 10 m²)									
Quercus rugosa	4	(21)	—	100	—	—	635	28.3	4.0
Q. laurina	5	(26)	40	60	—	—	910	62.8	8.8
Pinus sp.	5	(26)	100	—	—	—	2830	615.4	86.7
Abies religiosa	1	(6)	—	100	—	—	140	1.5	2.1
Buddleia cordata	1	(6)	—	100	—	—	160	1.8	2.5
Litsea glaucescens and Unidentified	3	(17)	—	100	—	—	40	0.1	0.0001

* Column headings for this table and tables 2 and 3: No. = number of individuals; (%) = total per cent composition; % trees in veg. levels 3, 2, 1, Gr. = per cent of total number of individuals represented in canopy, second, first, and ground levels; Total DBH = total diameter breast height; $\frac{\text{B.A.}}{\text{Ha.}}$ = basal area per hectare; % B.A. = per cent basal area.

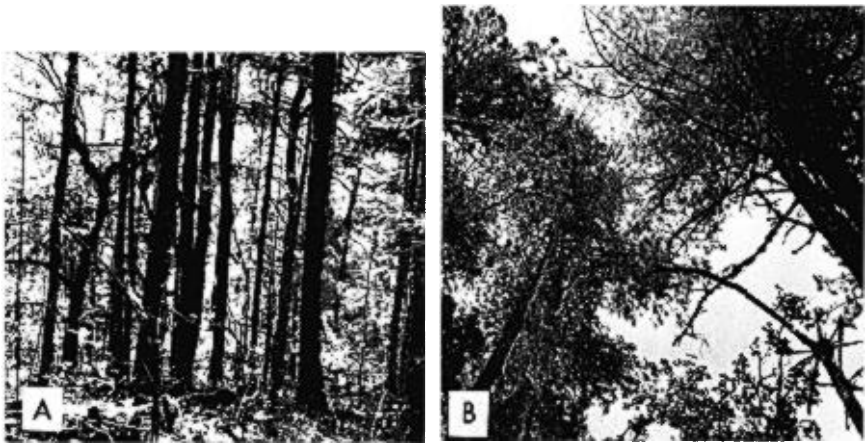

FIG. 2. Woodland communities of Cerro San Felipe, Oaxaca, in the Dwarf Jay study area. A. Mature humid oak-pine-fir climax forest near site of nest 2, 1966 (see Table 3, quadrat 1). B. Vertical view of open canopy of mature open pine forest, south facing slope near area shown in A. above (see Table 4).

quadrats. Also, by walking no more than 90 m from the nest site, an observer could find other jays foraging. Some of these seemed to be non-breeding birds traveling in small flocks (4 or 5 birds), but others occurred regularly in certain nearby places singly or in pairs, and probably were established breeders.

These two quadrats in contrast to the first four described had fir as one of the dominants, represented among the canopy constituents and prominent in the secondary layer. The exposure and slope resulted in poor drainage, cooler temperature and more shade, and, in quadrat 1, 1966, more herbaceous ground growth (Fig. 2A). *Quercus aáata* is a large heavy bodied tree like *Q. rugosa*, but apparently is restricted to mesic poorly drained areas. It has broad leaves of medium thickness, that are dark, green and waxy in texture.

Following are brief descriptions of these two quadrats to supplement quantitative data in Table 2.

Hillside quadrat 1, 1966. Exposure NE, 10 degree slope, Canopy 30 to 45 m in height. Well developed secondary layer at 6 to 12 m. Little ground level vegetation, with total screening effect of two canopies estimated at 70 per cent.

Hillside quadrat 2, 1966. Canopy sparse (evidence of larger trees having been removed), and dense secondary layer of 6 to 12 m in height. Weak first story 3 to 6 m in height with many small dead fir and oak. Effective closure from light at ground level 30 to 40 per cent.

TABLE 2

VEGETATIONAL COMPOSITION OF QUADRATS 1 AND 2, 1966 OF THE DWARF JAY STUDY AREA.

Tree Species	No.	(%)	Per cent trees in veg. levels 3	2	1	Gr.	Total DBH	B.A. Ha.	%B.A.
			(Hillside Quadrat 1, 10 m²)						
Quercus aáata	3	(27)	100	—	—	—	1750	226.0	68.0
Q. laurina	1	(9)	—	100	—	—	260	5.3	1.6
Litsea glaucescens	2	(18)	—	100	—	—	400	12.5	3.7
Pinus sp.	1	(9)	—	100	—	—	320	8.2	2.5
Abies religiosa	4	(36)	50	25	25	—	1005	81.8	24.5
			(Hillside Quadrat 2, 10 m²)						
Abies religiosa	28	(68)	—	71	29	—	2270	452.2	66.0
Quercus rugosa	9	(22)	33	33	22	11	1680	221.6	32.0
Quercus laurina	2	(5)	—	100	—	—	265	5.0	7.3
Litsea glaucescens, Arbutus? or *Arctostaphylos*	2	(5)	—	100	—	—	165	0.38	0.0004

Tables 1 (part) and 3 give data for quadrats not utilized for nesting by Dwarf Jays. The open pine forest (Fig. 2B) of quadrat 5, 1965, was within observation distance of our camp. This habitat is rarely entered by Dwarf Jays. On only one occasion did I see a Dwarf Jay cross this woodland, forage briefly and enter denser woodland adjacent to it. Barranca quadrats 1 and 2 were situated at the upper reaches of the subtropical barranca vegetation zone. This is so different in character that there was an almost complete difference in avifauna. In early April Dwarf Jays were occasionally seen foraging in afternoon hours in the uppermost parts of this zone. In 1966 and 1967, after nest-building was completed, no jays were seen at any time in such habitat. It is certain that they do not breed in it.

Following is a brief description of each of these three quadrats to supplement quantitative data in Tables 1 and 3.

Hillside quadrat 5, 1965. Exposure S, 45 degree slope. Open pine forest, with oaks distinctly subdominant and sparse. Canopy at 30 to 38 m in height and totally pine with less than 25 per cent closure. No secondary canopy; oaks slender and without crown structure. Carpet of pine needles, 10 per cent cover by sapling and herbaceous or shrub growth and bracken fern (*Pteridium*).

Barranca quadrats 1 and 2. These two quadrats were similar in general appearance, with fewer large trees in 2. Both were of westward exposure, on 45 degree slopes, and had similar layering. The third story canopy was at a height of 22 to 30 m (with one tree reaching approximately 38 m), the second story was at 10 to 15 m, and the first story at 1 to 3 m. Canopy closure was between 70 and 85 per cent, deeply shad-

TABLE 3

VEGETATIONAL COMPOSITION OF BARRANCA QUADRATS, 1965 NEAR DWARF JAY STUDY AREA.

Tree Species	No.	(%)	Per cent trees in veg. levels 3	2	1	Gr.	Total DBH	B.A. Ha.	%B.A.
			(Barranca Quadrat 1, 10 m²)						
Meliosma dentata	10	(100)	30	70	—	—	3455	907.5	100
			(Barranca Quadrat 2, 10 m²)						
Meliosma dentata	11	(58)	91	9	—	—	2160	314	95.1
Litsea glaucescens var. *subsolitaria*	5	(26)	—	100	—	—	422	13.6	4.1
Compositae or ?	3	(16)	—	100	—	—	187	2.5	0.8

ing much of the subcanopy woodland to the exclusion of a well defined second layer or dense growth in the first and ground layers.

Other Bird Species

The following list is of species I regularly observed and judged to be common to abundant in the study area oak-pine-fir forest and thus, like the plants, characterizing the jay habitat. No systematic attempt was made to census the avifauna of the entire area. Several other bird species, such as *Xiphocolaptes promeropirhynchus*, perhaps just as characteristic of the area but irregularly seen and apparently uncommon, are omitted here, as are several species, such as *Catharus frantzii*, common nearby in the subtropical vegetation of the deep ravines, away from Dwarf Jay habitat. Specimens of all these species were collected and deposited in the collection of the Moore Laboratory of Zoology at Occidental College.

Dendrortyx macroura, Columba fasciata, Caprimulgus vociferus, Hylocharis leucotis, Lampornis clemenciae, Trogon mexicanus, Lepidocolaptes affinis, Empidonax difficilis, Mitrephanes phaeocercus, Cyanocitta stelleri, Campylorhynchus megalopterus, Troglodytes brunneicollis, Henicorhina leucophrys, Melanotis caerulescens, Turdus migratorius, Turdus assimilis, Turdus infuscatus, Myadestes obscurus, Catharus occidentalis, Ptilogonys cinereus, Myioborus miniatus, Ergaticus ruber, Vermivora superciliosa, Pipilo ocai, Atlapetes pileatus, A. brunneinucha.

The Forage Niche and Foraging Behavior

A necessary constituent of Dwarf Jay breeding habitat is a prominent sub-canopy layer of forest vegetation. Such a layer is composed of the

TABLE 4

PER CENT OF TIME SPENT (BIRD-MINUTES) FEEDING BY DWARF JAYS IN DIFFERENT LEVELS AND ZONES OF VEGETATION

	Ground	Ground level vegetation shrub, low	First story waist to head high	Second story Trunk	Second story Foliage	Third story Sub-canopy	Third story Canopy	Totals
				105	196.6	32	36	
			[——15——]*		+		+	
				[——143——]*		[——70——]*		
Bird min	4.1				444.6		138	586.7
Per cent of total time	0.7	Trace	2.6		75.7		23.5	

* Bracketed times indicate foraging activities spanning two or more zones in a manner precluding designation of time spent in one.

crowns of trees having a DBH of approximately 50 to 200 mm mingled upwardly with the lower branches of taller trees to form a subcanopy area beneath the primary canopy. The latter is sufficiently open (less than 50 per cent closure) to allow the development of a strong second layer. The third layer and fourth or seedling-shrub layer seem to be of little importance to the jays. In all jay habitats analyzed on Cerro San Felipe these layers are very weakly developed and were rarely visited by the birds in foraging, usually as they chased a flying insect that had dropped from above. Dwarf Jays occasionally enter the subcanopy but unlike Steller's Jays (*Cyanocitta stelleri*) that inhabit the same forests, Dwarf Jays do not often forage at these upper levels. When they do, it is usually not in nesting habitat but as they forage across relatively open areas of forest lacking lower vegetational layers.

Over 80 per cent of the foraging time of Dwarf Jays is spent from the bottom of the primary canopy to the top of the first layer of trees. Census of time spent feeding in the various layers and zones was made irregularly through the 1965–66 years of the study, and the results are summarized in Table 4. Observations in 1967 were consistent with indications of these data.

Within the layer chosen for foraging, Dwarf Jays look for insect prey in and around epiphytes, including bromeliads, ferns, and lichens. In this aspect of their feeding, they are quite titmouse-like, hanging upside down from small branches, hovering beneath a limb and suddenly clutching it to peck something, and in general making an assiduous investigation of

TABLE 5

STOMACH CONTENTS OF FOUR SPECIMENS OF DWARF JAY FROM CERRO SAN FELIPE, OAXACA

	Coleoptera	Diptera	Hymenoptera	Insect larvae, eggs	Plant fiber
RTM A–37 ♂ ad., testes 3 × 5 mm, no molt. 7 July 1963.	Includes weevils (Curculioninae)	Tipulids*	Wasps	Unident.	—
RTM A–51 ♀ ad., ovary gran., molting. 7 July 1963.	Weevils (90 per cent)	1 Tipulid 1 short-wing fly	—	—	—
RTM A–46 ♂ ad., testis 2 × 3 mm, molting. 6 July 1963.	Bark beetles (Scolytidae ?) Weevils	—	—	3 whitish larvae	—
RTM A–168 ♂ ad., testes 3 × 5 mm, no molt. 16 April 1965.	50 Bark Beetles (Scolytidae and 1 Meladryidae ?)	1 Tipulid	—	1 egg 2 larvae	trace

* Where no numerical designation occurs, contents consisted of a complex admixture of fragments.

all crevices that might hold food. They break open plant galls to get larvae from within. These two activities, in about equal proportions, comprise most of their feeding methods. Less frequently observed foraging behavior includes searching for food beneath the peeling bark fragments of the trunks and larger limbs of trees, and chasing slow flying insects. Most jays are known to eat acorns. The Dwarf Jay lives in oak forests that produce small acorns of appropriate size for this small jay, but acorns have yet to be confirmed as a diet item.

Table 5 shows the results of analysis of the contents of four Dwarf Jay stomachs and suggests the largely insectivorous nature of the diet.

Weather

The climate of high elevations (2400–3000 m) of Cerro San Felipe is cool-temperate. There is a rainy season from June through October or

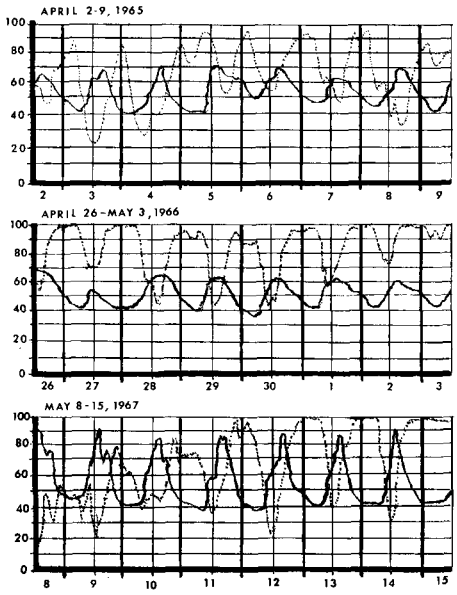

FIG. 3. Temperature and relative humidity records for three selected weeks, Cerro San Felipe, Oaxaca. Adapted from hygrothermographic charts, these records were made at ground level in shade in Dwarf Jay habitat. Dotted lines equal relative humidity, solid lines equal temperature in Fahrenheit degrees. Dark vertical graph lines designate midnight, light vertical lines, noon.

November and a dry season from then until late May. The rare precipitation of the dry season may be in the form of snow flurries. Light frosts occasionally occur. I have no experience in the area in the period from mid-July to late March, but Mr. Boone Hallberg, a botanist resident at nearby Ixtlan de Juarez, provided the foregoing generalizations. My experience in the area almost spans the breeding season period of the Dwarf Jay, from late March to mid-May. Figure 3 shows the fluctuations in temperature (F) and relative humidity in three periods, one from each of the three successive years of this study. Figure 4 summarizes facts on cloud cover and precipitation for the periods of study. Comparing information in these two figures the following generalization about the weather in the breeding season can be made. Early April has typical dry season weather. Days are cool and consistently clear with only scattered high cumulus clouds. Temperatures range from the low 40's at night to the high 60's F in the daytime, with daily mean in the 54 to 57 range. Relative humidity fluctuates greatly, falling to the 40's or lower around noon depending on wind

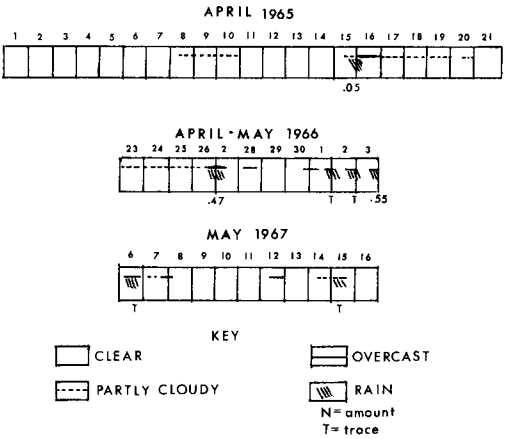

FIG. 4. Weather conditions in the three study periods on Cerro San Felipe, Oaxaca. Rainfall in inches.

and rising sharply thereafter as the sun disappears behind the high ridges and peaks to the west, reaching the 80's and 90's around midnight.

The year 1966 was an unusually wet year with the first indications of the onset of the rainy season appearing by late April. Because of the greater prevalence of overcast days and precipitation, temperatures averaged even lower than in 1965 (daily mean approximately 54) and ranged from 36 to 66 from 26 April to 3 May. Humidity was higher, never fell below 40, rose daily to the 90's and averaged in the low 70's.

The year 1967 was a "normal" year; a few days were overcast and rainy or misty and frequent partly cloudy conditions existed. Temperatures ranged from 38 to 91, with a daily mean of from 60 to 64.

The regularity of fluctuations, the consistent inverse correlation of temperature and humidity, the persistence of daily humid periods, even in the dry season, and the virtual lack of freezing weather are certainly in contrast to conditions of a cool temperate climate at higher latitudes. These climatological factors are the basis for the prevalence of a tropical aspect to the forest, the existence of evergreen broad-leaved trees, rank epiphytic growth of bromeliads and orchids, and representation in the avifauna of such distinctly tropical avian genera as *Smaragdolanius, Diglossa,* and *Trogon.*

THE REPRODUCTIVE CYCLE

Onset

In the non-breeding season, Dwarf Jays move about and forage in loose aggregations of four to perhaps ten individuals, which are in turn part of

multispecies flocks. Within such groups, the onset of the reproductive period becomes evident in the pairing of individuals, the separation of the jays from the other species, and courtship feeding. On 4 and 5 April 1965, I observed small groups of Dwarf Jays in the study area. On 5 April at 07:15 at the edge of a second growth oak woodland, I encountered two birds actively feeding on larvae in oak galls. These they removed from the backs of oak leaves, and hammered open in typical corvid fashion. In a period of approximately ten minutes, courtship feeding occurred once. The presumed female was sitting quietly in a low tree about ten feet from the ground. The presumed male approached, and fed the female quickly without displaying. Nor did the female display. Moments later a third jay appeared nearby and the presumed male of the pair and this new bird engaged in very active hopping about in what I interpreted as a display of territoriality. The display culminated with the interloper being quietly pursued back into the forest. Ten minutes later two jays again approached the foraging pair from the point of the interloper's retreat and the four birds foraged in the area for 45 minutes before moving away. In mid-afternoon I encountered four jays feeding in the second story of a deep ravine (near barranca quadrats 1 and 2). No courtship feeding was observed but I saw one attack another, apparently in an attempt to drive it away. The attack involved erect posturing, tail spreading, and active pursuit among the branches. Such encounters as this I interpret as the first evidences of territorial aggression, soon to be followed by complete separation of the aggregations into pairs, holding exclusive territories.

I soon discovered a regular pattern of movements and activities that the Dwarf Jays were following in this period. In early morning hours the birds were in small groups or pairs in the breeding habitat—the oak-pine-fir woodland and forest. Occasionally pairs engaged in courtship feeding and visiting the area of the nest tree and site. Nest building occurred for a few minutes before the birds returned to foraging and courtship feeding. By late morning the birds moved away from the nest area and by noon had vacated the hillside oak-pine-fir habitat completely for the deep ravines in which they remained until late evening. I noted their return to the hillside forests on several occasions near our camp, situated on the brink of a large ravine. The birds called frequently, moving in the lose aggregations past us from tree to tree and on up into the areas above the camp, not pausing to feed or rest as was characteristic of them in their foraging periods. This pattern of behavior prevailed until eggs were laid.

Nest building

Nest building apparently begins in March; on 4 April I discovered a nearly completed Dwarf Jay nest 20 feet up in the crown of a scraggly oak

(*Q. rugosa*), in quadrat 1 (Table 1). At 09:40 the pair was foraging and calling softly. Suddenly one bird, the presumed female, stripped a strand of usnea from a branch and flew silently away along the hillside, to the nest tree. She entered the crown of the tree and quickly emerged, having deposited the material. Again she flew out of sight only to return in two minutes with more of the material. Calling quietly she went directly to the nest. Again she quickly departed out of sight, at 10:00. I watched at the nest site until 11:00 but saw no further activity. Apparently I had witnessed the end of the morning's nestbuilding activities.

Nest 1 was the only one on which I was able to gather any information on activities associated with nest building and this only in the closing stage. My assistant Ray Jillson spent 3.5 and 2-hour periods respectively during the mornings of 5 and 6 April observing this nest. The density of the foliage made it impossible to see if birds arriving at the nest were bringing nest material. Moreover, arrivals and departures were overlooked several times because of poor visibility and the secretive nature of the birds. Jillson's observations do provide some idea of the frequency of coming and going at the nest and the coordination of the pair's activities. One bird, presumably the female, seemed to be attended by the other bird. I have concluded from these and other observations that activities at the nest, include nest sitting, cup-shaping, and courtship feeding. The presumed male sometimes visited the other bird at the nest and otherwise stayed nearby in a tree or foraged in the surrounding woodland, ready to accompany its mate. From 07:00 to 10:30 (210 min.) on 5 April, the nest was definitely vacant for 11 periods of 50 (the first 50), 22, 3, 1, 7, 7, 4, 10, 12, 1, and 1 min. Both birds were at the nest together for 6 periods of 3, 5, 1, 1, 1, and 1 min. One bird was at the nest 16 periods of 3, 5, 1, 2, 1, 3, 4, 1, 1, 3, 5, 11, 1, 2, 1, and 1 min. Both birds were in trees near the nest for two periods of 14 and 1 min. All of these periods were given to the nearest minute, except all periods of 30 sec. to 1 minute are listed as 1 min. Seven minutes remain unaccounted for.

The frequent visits to the nest, and interaction between members of the pair near and at the nest, recall the activities of Blue Jays (*Cyanocitta cristata*) and Mexican Jays (*Aphelocoma ultramarina*) prior to egglaying (Hardy, 1961: 27, 35 to 36). The nests in all these species seem to serve as centers for sexually attentive activities presumably related to synchronization of the states of the participating adults. Although we did not observe copulation in the Dwarf Jay, this should be the time of its occurrence. Following observations on 5 and 6 April, there was less activity observed at nest 1, until the time of the actual egg-laying.

TABLE 6

NESTS OF DWARF JAYS

Nest	Date found	Tree species	Status	Height in Meters	Place in tree	Vegetation layer	Contents
#1	4 Apr. '65	*Q. rugosa*	late construction	6	crown	2	12 Apr., 1 egg 13 Apr., 2 eggs
#2	7 Apr. '65	*Q. rugosa*	late construction	4.5	subcrown	2	12 Apr., 2 eggs
#3	13 Apr. '65	*Q. laurina*	?	15	crown	2	15 Apr., 2 eggs
#4	16 Apr. '65	*Q. laurina*	2 eggs ?	4.5	end of low branch 30 ft. tree	2	21 Apr., 2 eggs
#5	21 Apr. '65	*Q. laurina*	3 eggs	6	crown	2	21 Apr., 2 eggs
#1	24 Apr. '66	*Q. laurina*	3 eggs ?	3	crown	low 2	4 May, 3 eggs
#2	24 Apr. '66	*Q. aáata*	incubation ?	10.5	end of branch	2	4 May, incubation
#3	27 Apr. '66	*Q. rugosa*	incubation ?	10.5	end of branch	2	4 May, incubation
#1	7 May '67	*Q. rugosa*	3 hatchlings	4.5	subcrown	2	16 May, young
#2	10 May '67	*Q. laurina*	young (age?)	6	subcrown	2	16 May, young

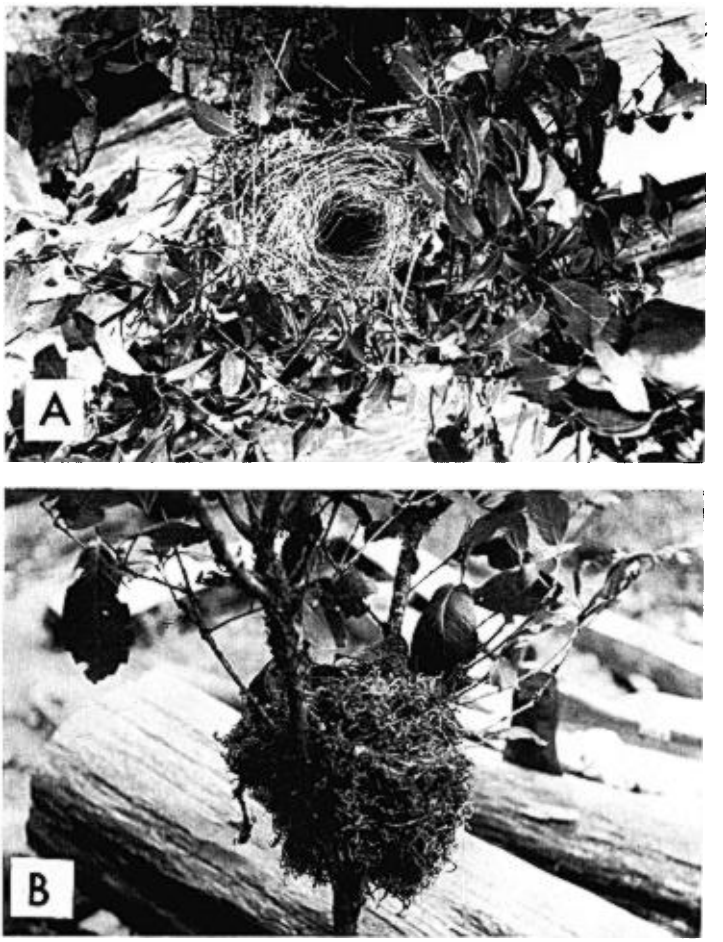

FIG. 5. Two nests of the Dwarf Jay, removed from original sites. A. Nest 3, 1965, showing cup. B. Side view of Nest 1, 1965, showing bulky moss construction.

Egg-laying

On 12 April I found jays in the vicinity of nest 1, in late afternoon; the first egg was also in the nest. The birds gave harsh rasping cries and fluttered about in the nest tree as I checked the contents. Nest 2 checked the same day had two eggs. On 13 April each nest contained two eggs in late afternoon. No additional eggs were laid in either; these were complete clutches, and each female began regular incubation from this time onward. Table 6 provides data on nests and eggs discovered in the three years of

study. Data are not sufficient to allow determination of clutch size variation. However, complete two- and three-egg clutches were found, and no indication of larger clutches was obtained. The nests were exclusively in oaks, and were either in the crown of a second story tree, or at the end of a branch in the same layer.

Description of Nests and Eggs

The nest and eggs of the Dwarf Jay have apparently not been previously described. The following description of them is based upon three nests (Moore Laboratory N–564, 565, 566) and eggs contained in 566. This is nest 2 of the present paper (see Table 6). Nest 564 (no. 3): outside depth 18 cm, outside diameter 19 cm. Nest cup 7 cm wide, 7.5 cm deep. Nest 565 (no. 1): outside depth 14 cm; outside diameter 16 cm, cup width 6 cm, depth 7 cm. Nest 566: outside depth 20 cm, width 19 cm; cup width 8 cm, depth 7 cm. Composition except for lining of the three nests is essentially the same. Each is a bulky but compact mass of mosses and lichens, with a few (20–30) twigs 5 to 15 cm long and 2 to 5 mm in diameter in the mass, largely around the top where they give strength to the form of the rim and cup. Nests 564 and 566 are lined completely with pine needles, while 565 is lined with fine rootlets, a few strands of grass and a few pine needles. Each of these nests was constructed in the fork of a tree, and size may be governed by the necessity to fill the complete space to attain strength. The outside size of the nests is large in comparison to the size of the birds that build them and they are strong for the nest of a jay. Figure 5 shows top and side views of typical Dwarf Jay nests. The size of the nest plus the deep cup may afford additional protection for the eggs and young in the cool climate of the nesting season. The sturdiness of the nest is attested to by the fact that abandoned ones remain intact for long periods. I found one nest in 1966 that looked absolutely fresh in 1967 except for accumulated leaves in the cup. Old nests of jays, as well as of other birds (such as the similar nests of *Catharus* thrushes) are eventually taken over by ferns and other epiphytes that thrive in the foothold provided by the accumulated matter of the nests. The many seemingly fresh nests, only a very few of which contain eggs or young, may serve as a buffer to predation by snakes, and birds, visiting all nests with the expectation of finding prey.

Eggs.—One egg that I collected measures 25.9 × 18.2 mm. In shape it is precisely between oval and subelliptical following Preston's classification (1953:166). The ground color is a pale, dull greenish blue, and this is finely and uniformly speckled and splotched with grayish olive and dark olive, heaviest at the large end.

Discussion.—Lack (1948:26–27) and Skutch (1949) point out the fact that tropical latitude birds whose temperate latitude relatives normally have four and five or more egg clutches characteristically have smaller clutches. Blue and Steller's Jays, and Mexican and Scrub (*A. coerulescens*) Jays regularly have four- or five-egg clutches (Bent, 1946). The range of the Dwarf Jay is in tropical latitudes and seemingly the bird's clutch size of two or three eggs is adjusted to the more nearly uniform tropical aspects of its breeding climate, rather than to its generally cool temperature. The small clutch size may be correlated with short day length, which Frith (1957) points out is an environmental factor that all birds of middle latitudes face.

Incubation

Roles of the sexes.—It is characteristic of corvids that only the female incubates (Kendeigh, 1952:243). According to my experience with several species (Hardy, 1961) the female is fed at or near the nest by the male and also leaves the nest at varying intervals to feed, preen, and defecate. At such times she is often accompanied by her mate, the nest being left unguarded. Table 7 summarizes diurnal incubation rhythms and associated behavior during incubation in the Dwarf Jay from approximately 35 hours of observations at nine nests. Since there was never any indication that more than one individual of a pair sat on the nest, I conclude that the Dwarf Jay is a typical corvid of the asocial solitary type. The assumed male's behavior was as described above; there was no indication of helpers at the nest, or indeed of any other Dwarf Jays but members of the pair in the vicinity of the nest.

Incubation period.—No single nest was studied from egg-laying through hatching; therefore the exact incubation period of the Dwarf Jay remains unknown. The data at hand, however, do suggest that the period is around 20 days, if we assume that synchrony of activities prevailed in the population under study and the onset of reproductive activity coincided in the three years of study. Both assumptions are strongly indicated by the data and observations.

Incubation behavior.—The lack of previous records of Dwarf Jay nests suggested that the species' nesting habits and nest situation might be so secretive that the nest would be difficult to discover and observe. The jays can be silent for long periods and are difficult to follow as they forage and move through the forest. If an observer does locate a foraging Dwarf Jay in the nesting season particularly after the time of egg-laying, and then keeps persistent watch on the bird it will eventually go to its nest. Moreover, it will behave no more secretively near the nest than at any other

TABLE 7

SUMMARY OF DATA ON INCUBATION AND ASSOCIATED ACTIVITIES AT SIX NESTS OF THE DWARF JAY, 13–20 APRIL 1965 AND 24 APRIL–3 MAY 1966

No. Observation Days	15	
AM Observation Time	340	2122 min
PM Observation Time	1782	
No. Observation Periods	22	
Mean Length Observation Period	96	
Time Female On Nest	1846	(87) *
Time Female Off Nest	276	(13)
Time Male Fed Female At Nest	22	approx. 1/hr
Time Male Fed Female Off Nest	10	

* Numbers in parentheses are percentages.

place. Dwarf Jays, in fact, seemingly ignore a human observer who remains quiet and inactive, even when the watcher is within 8 to 10 m of the nest.

An adult upon approaching the nest usually lands in a nearby tree, then flies to the nest tree, landing below or to the side as it flies to the nest and occasionally calls at the nest. Upon the approach of the male to the nest while the female incubates, the female may leave the nest to meet him or await his arrival. In either case she typically crouches low and extends the wings slightly and flutters them, at the same time giving a begging call—a juvenile-like whining sound. The male then promptly feeds its mate.

The male may forage for several minutes in nearby trees immediately prior to and following visits to the nest. Otherwise he forages out of sight of the observer near the nest, but within a distance that makes him audible and the calls of the female at the nest audible to him. When she leaves the nest in the absence of the male, she usually joins him or is joined by him. She occasionally calls upon leaving the nest and is answered by the male. Rarely does she forage near the nest site, except shortly before returning to the nest. The habit of the birds leaving the vicinity of the nest to forage probably aids in preventing predators from discovering the nest by the obvious activities of the adults near it.

Typically, the female incubates quietly, only occasionally shifting her position. The small bird sits so low in the cup that only the bill and end of tail are visible from slightly below nest surface level. This fact also may be one of the functions of the large nest-to-bird ratio and reduce the obviousness of the bird to a predator.

Length of periods on and off the nest.—There was no indication of a change in the incubation habits from early to late incubation. Sitting periods of the females are irregular throughout, varying from a few minutes to over two hours. The maximum time of a sitting period is not known, since the longest ones I recorded either were commenced prior to or persisted after observation time. If all the complete time periods in my observations are averaged (omitting the periods for which either the end or beginning was not witnessed), the mean length of sitting period for the female is 24 minutes (range 2 to 77). If all periods are averaged, the mean is 32 (range 2 to 120). It is perhaps advisable, considering the paucity of the data, to state merely that sitting times vary irregularly, tending to greater length and without interruption by the male to feed the female in afternoon hours.

There is a tendency for the earliest period off the nest in the morning to be longer than subsequent ones. Thirty-five off-periods, omitting incompletely watched ones, totaled 265 min and averaged 7.5 min, while 16 opening-off periods (observation periods which began with no adult at the nest), even those probably not the female's first off-period of the day average 10 min.

Apparently the male's visits to the nest are governed solely by the female's presence. Whether he feeds her on or off the nest depends upon her behavior at his approach. He never goes to the nest if she is not there in this phase of the cycle.

Intolerance of birds to physical disturbance of nest.—On several occasions I examined the contents of Dwarf Jay nests in the absence of adults apparently without disturbing activities. On two occasions, at nest 1 and 3, 1965, I sought to ascertain nest contents and was discovered in the act by the adults. They were vociferous, giving harsh rasping calls which I otherwise never heard, and flitted about within a few feet of me. Neither pair were ever seen at their nests again. In each case the full clutch of two eggs had been laid. They were not incubated after the disturbance and were collected (nest 1) and disappeared probably due to predation (nest 3) within three days.

If birds typically reacted in this way to nest disturbance, few life history studies could be conducted. The reaction of the Dwarf Jays suggests that either predators are few or that when disturbance does occur it almost al-

ways is by a predator that robs the nest, removing any purpose for the birds to return to it.

Although snakes and large arboreal lizards are either rare or nonexistent in the habitat of these jays, Steller's Jays and Barred Wrens (*Campylorhynchus megalopterus*) probably are potential nest predators. Yet Dwarf Jays would seem capable of defending against either of these species, neither of which is likely to approach in the presence of the nest owners. Squirrels were uncommon in the study area; I never saw one in the secondary layer where the jays' nests were situated. I have no information on the possibility of nocturnal predators.

Care of the Young

In 1966 the study terminated before young were hatched in any nest under observation. In 1967, the first of two nests discovered contained three hatchlings on 6 May, when it was found. Located within the territorial area of nest 1, 1966, it was 60 m up the ravine slope from the barranca creek, 4.5 m up in the crown of an oak (*Q. rugosa*).

I estimated that when found the young were approximately 3 to 4 days of age. They seemed virtually naked but could not be examined at close range due to the inaccessible position of the nest and my fear of disturbing activities of the adults. The eyes were bulbous and closed. The mouth lining was pinkish yellow. Observations were begun at this nest and occurred from 8 to 16 May.

Table 8 summarizes the timing and frequency of brooding and feeding, at one nest regularly observed. A single observation period at a second nest is included, but observations were not regularly made at the second nest because it was so situated that accurate account of events there could not be kept. The data suggest the following: both male and female feed the young with equal frequency; only the female broods; brooding, except in late evening and nocturnal hours diminishes after the first week of nestling life, while feeding trips by the adults increase in frequency from two to four an hour to about double that frequency. Fecal sacs are usually removed from the vicinity of the nest and are rarely eaten at the nest. The basic character of brooding and feeding of young is similar to that in the north temperate Scrub Jay (Amadon, 1944:14–15) and the Blue Jay (Hardy, 1961:64–68).

The service of the adults as in Blue and Scrub Jays was not coordinated. Occasionally they arrive at the nest to feed simultaneously, but their arrivals and departures were not alternated or synchronized. This is undoubtedly due to the fact that in jays, the female does practically all the brooding and her cycles of feeding and brooding are independently coordinated with

TABLE 8
CARE AND FEEDING OF NESTLINGS BY DWARF JAYS

Date (Nest)	Time beginning	Total time (min.)	Brooding (min.)	♀ feeds young	♂ feeds young	Adult feeds young	♂ feeds ♀ who feeds young	Removes fecal sac (eats)
8 May (#1)	16:30	60	25 1*	1	1			
9 May (#1)	08:20	120	9 15 sec 44	3	5	1		1
11 May (#2)	07:00	120	65 20			1?		
11 May (#1)	10:20	120	5 18 1	3	2		1	(1)
12 May (#1)	08:30	60				5		1
13 May (#1)	17:00	30	adults forage near nest					
14 May	10:00	120		1	1	12		3
14 May (#1)	17:00	60	32	2 attempts, young refuse				
16 May (#1)	07:00	60	30 sec 35		1	1	1	1
Total Frequency		750	25:45	8 0.64/hr	10 0.80/hr	20 1.60/hr	2 0.16/hr	7 0.56/hr
						3.2 hr		

* Bar over numeral indicates activity was in progress as observation began; bar under numeral indicates activity continued beyond termination of observation.

each other and do not depend on the male brooding or guarding the nest. After bringing food the male seldom stays at the nest for more then a few seconds. The female did not follow or beg from her mate and was rarely fed by him.

It proved impossible to arrange study of the reproductive cycle of the Dwarf Jay when and after the young leave the nest. Thus, the number of days the young spend in the nest and the nature and time of their care by the adults in the fledgling stage remains unknown. In the Moore Labora-

tory of Zoology there are four juvenal specimens. Two, apparently just out of the nest are stubby-tailed, collected by Toro Aviles, on Mt. Totontepec, Oaxaca (some 75 airline km east of Cerro San Felipe) on 12 and 18 April 1942. These specimens had led me to expect that my scheduled times of study would allow me to observe the young leaving the nest. Either nesting time is regularly earlier on Totontepec, the year 1942 was an early year, or Aviles' dates are incorrect. Lamb collected one full-grown juvenile on 5 July 1942 near the border between Puebla and Veracruz, at the top of Acultzingo grade (La Puerta) about 35 miles SW of Orizaba, Veracruz, and his notes suggest no evidence of this young being cared for by adults, which he also collected.

I spent the period 4 to 8 July 1963 in the study area on Cerro San Felipe studying Dwarf Jays. Based on observations in the other years of study, this would have been at a time when the young had been out of the nest for about six weeks. At no time did I observe any indication that any Dwarf Jays were still dependent on others for food. Flocks of from 5 to 10 birds were watched on three days as they roamed the woodlands foraging in company with other species, especially the wren *Campylorhynchus megalopterus*. Short (1961:341–343) has written of the multispecies flocks in which this wren and the jay are prominent constituents on Cerro San Felipe.

Breeding activity of the jays had ceased before early July. Three individuals collected and now in the spirit collection of the Moore Laboratory had just begun the prebasic molt. In a female (A–37) with a minute granular ovary, the third primaries were new quills with 1 cm brushes. The second primaries were soft but fully grown. Molt of under and upper tail coverts was in progress, and scattered wing coverts and body feathers were also molting. Another female (A–51) was like A–37 and in addition was replacing the innermost rectrices, which were sheathed. A male with left testis 3×2 mm was molting first and second primaries, upper and lower coverts of remiges and rectrices.

No molt data were taken for two specimens preserved as skeletons. One, a male, had testes 8×5 mm and a female, with skull incompletely ossified and the bill lining white (an indication of first year age) had a very small granular ovary.

Lamb's two adult specimens from La Puerta, Veracruz, mentioned above, were completing the molt of the 5th and 6th primaries.

Except for the fact that the Dwarf Jays observed from 5 to 8 July on Cerro San Felipe were in small loose flocks, I could detect no basic behavioral differences between them and breeding birds in their movements, calls, or foraging habits.

I find no evidence in the literature to indicate that the Dwarf Jay migrates or otherwise displaces itself from its nesting grounds, in the non-breeding season.

Timing of the Breeding Season of Dwarf Jays

As previously emphasized, although this jay is representative of an avifauna of largely tropical affinities, it is nonetheless an inhabitant of a cool temperate climate. Its breeding season begins well in advance of the rainy season and the young are on the wing, probably largely independent of adult care by the onset of the rains. Pitelka (1958:45–49) studied breeding, age, molt, and food abundance of Steller's Jay in the Queen Charlotte Islands, coastal British Columbia. He suggests that in that species molt, rather than breeding, was critically timed to the season of maximum food abundance. In the Dwarf Jay habitat, maximum abundance of food probably occurs in the first months of the rainy season, July through September, suggesting that this species may be similarly adapted.

VOCALIZATIONS

I have previously discussed the vocal character of the Dwarf Jay (Hardy, 1964:3–6), with special reference to the species' taxonomic affinities. As pointed out then, the Dwarf Jay has one of the smallest basic repertoires known among jays. There is one species-specific call, variations in delivery of which appear in different contexts. This call, a doubly flexed, shrill, nasal, *shreéup* (Fig. 6A) may be given singly, in multiples of two or three, rapidly almost run together, and with bill either open or closed. In these ways only is variety obtained. A short, soft closed-billed utterance of this call serves as a contact-conversational note between two adults close to each other. An open-billed singly uttered version serves as a contact note when the birds are farther apart and out of each others sight. Rapid multiple versions serve both as high intensity activity notes among foraging individuals in a loose flock, probably correlated with flock movement and cohesion, and in excited reference to a predator, human being, or comparable stimulus evoking suspicion or examination.

Besides the *shreéup* there are generalized begging notes, rapidly uttered, that are not species-specific. These are given by the female toward the male in solicitation of food. Another generalized and rarely heard call is the harsh rasp (Fig. 6B) that is given in intense "fear" and "rage." The adults gave it when they found us examining their nest.

The limited character of the Dwarf Jay vocal repertoire may be a function of the simple social structure of the species, especially during the nesting season. It is also correlated with the simplicity of sexual display (so far as known involving only courtship feeding). These behavioral

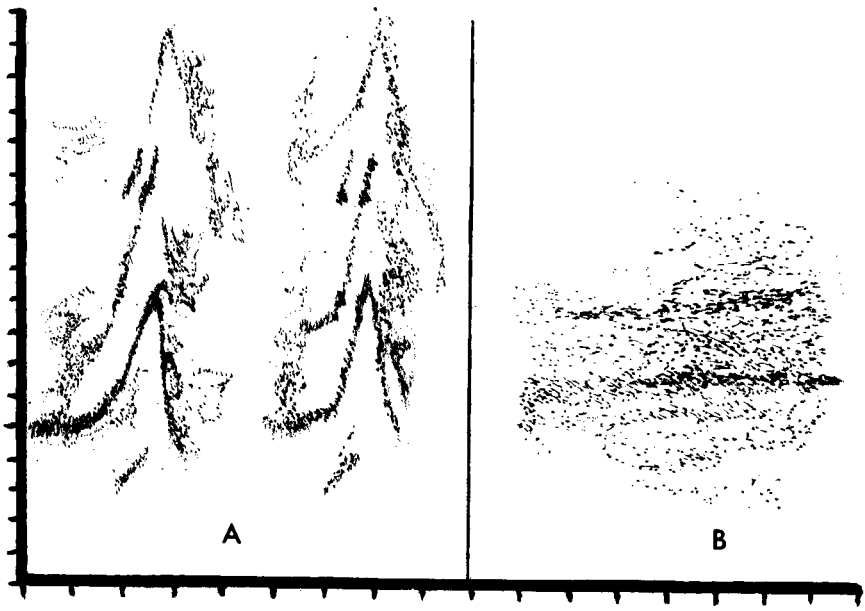

FIG. 6. Ink drawings of sonagrams of two Dwarf Jay calls. Narrow band pass filter. Frequency is measured on the vertical axis at 500 cycle intervals to 10 Khz. Time is measured on the horizontal axis at 0.2 sec. intervals. Both recordings from Moore Laboratory Master Tape 13, 12 April 1965, nest 1, Cerro San Felipe, Oaxaca, by J. W. Hardy. A. Two doubly inflected alarm calls (*shreéup*!). B. Harsh rasp given in "fear" or "rage."

characteristics eliminate the necessity of a complex vocabulary with distinctive components that can result from completely distinct types of operation of the syringeal apparatus. The few variations of vocal sound in this species seem to be handled by variations on a single basic syringeal operation that produces the *shreéup* plus differences superimposed by the strength of air flow and the opening or closing of the mouth cavity.

PREDATORS

Dwarf Jays, while intently foraging in the top of the second story of trees, form excellent targets for cruising Sharp-shinned Hawks (*Accipiter striatus*). This species seemingly preys on the jay. In 1965, while I was observing nest 3 near our camp, one of these small hawks, apparently a male darted and almost seized the male jay as he hopped about in the canopy of the nest tree. The jay called twice and fled. The hawk perched nearby and then quickly flew away. At nest 2 on 19 April 1965 when there

had been two eggs in the nest for a week, I spent two hours on watch in the afternoon. No jay appeared at the nest. At 15:40 a Sharp-shinned Hawk caught a small bird immediately down the ravine from my observation position (as evidenced by the sudden flurry of small birds and anxious calling). Moments later the hawk flew by and I believe it was carrying a Dwarf Jay. It appeared a few minutes later, flying by without prey.

In 1967 near nest 1, I also observed a Sharp-shinned Hawk dart past the nest area, causing a flurry of birds including the jays. The hawk this time did not attack a specific bird.

SUMMARY

In 1963, 1965, 1966, and 1967, I studied aspects of the life history and ecology of the Dwarf Jay (*Aphelocoma nana*) in the montane forests of Cerro San Felipe, Oaxaca, Mexico. This jay is an inhabitant of humid oak-pine-fir forests on the mountain between about 2500 and 2900 meters elevation. Its occurrence is closely correlated with the existence of and largely confined to a secondary layer of trees below the canopy. The bird seldom ventures to shrubs and the ground vegetation or to the high canopy of the forest. It rarely enters pure pine forests, also present in the study area. It is sedentary. In foraging, the Dwarf Jay attacks plant galls and gleans arthropods from epiphytic growth. It is adept at exploring small branches and their epiphytes in a titmouse-like fashion. Occasionally it takes medium-sized flying insects. In the non-breeding season it frequently travels in small bands of less than a dozen birds associated with other species, such as the wren *Campylorhynchus megalopterus*.

The Dwarf Jay is an asocial species in the nesting season, pairs occupying exclusive areas away from other breeding individuals of the species. Although widespread in the chosen habitat, the Dwarf Jay population studied was of low density. This may have resulted in the lack of frequent territorial behavior, but the exclusive occupance of areas by pairs and occasional encounters early in nesting indicate that the species is territorial.

Nesting began in late March. At that time small groups of jays in which pairs were engaged in courtship feeding were seen. Both members of a pair are attendant in nest construction, both probably contributing to nest building. I found nests nearly completed in the first week in April. Nests are placed in the crowns of second story oaks or near the end of a branch. They ranged in height from 3 to 15 m. Nests are large in relationship to the size of the jays themselves. Construction is of twigs, mosses, and pine needles and the finished nest is compact and sturdy. In the time of nest building, the birds desert the nest area in afternoon hours to forage in deep ravines. They build in morning hours. Egg-laying commenced on 12 April in 1965. Complete clutches were composed of two or three eggs, which are pale-greenish-blue, marked with olive. Incubation is seemingly by the female only. She is attended by her mate, sometimes fed at or near the nest, and usually accompanied by him in her time off the nest. She incubates in periods ranging from 2 minutes to longer than 2 hours. The longer periods occur in afternoon hours. The incubation period was not precisely determined but is apparently 20 days or longer as in other New World jays. Hatching occurs in late April or early May. At the one nest studied in detail in the nestling stage, both male and female fed the young and only the female brooded. The fledgling stage was not observed, but observations made in early July, 1965, indicate that young

are completely independent by this time, and the jays already are in the non-breeding bands with wrens and other resident species.

The vocal repertoire of the Dwarf Jay is extremely simple, consisting largely of variations on the production of a single basic component, the *shreéup* call. At times of extreme anger or fright the birds emit a harsh rasping call.

The Sharp-shinned Hawk is seemingly a predator of the Dwarf Jay.

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