

RELATIONSHIPS AMONG THREE SPECIES OF JAYS WINTERING IN SOUTHEASTERN ARIZONA

PETER W. WESTCOTT

Department of Zoology
University of Florida
Gainesville, Florida 32601

During the autumn and winter, flocks of Scrub Jays (*Aphelocoma coerulescens*), Mexican Jays (*A. ultramarina*), and Steller Jays (*Cyanocitta stelleri*) frequent the oak-grassland (open encinal) foothills of the isolated mountains of southeastern Arizona, a habitat in which normally none of them breeds. During the breeding season they are ecologically isolated, although some interaction may occur between Scrub and Mexican Jays, or between Mexican and Steller Jays (Pitelka 1951; Marshall 1957). Little information is available on interspecific assemblages of the New World jays, and this study of sympatric flocks of these habitually gregarious species provides data on the mechanism of flocking.

To observe the interactions among these jays, I visited selected sites in the oak-grassland association between 4000 and 5000 ft of Jacoben Canyon, Pinaleno Mountains, Graham County; Box and Gardner Canyons, Santa Rita Mountains, Pima County; Control Road and Hitchcock Highway, Santa Catalina Mountains, Pima County. I traversed the habitat systematically and watched the various flocks with 10-power binoculars, often sitting on a hillside without moving for several hours. When I avoided sudden movements close to a flock, the jays were not disturbed by my presence and often fed all about me.

All observations were recorded immediately in a field notebook. I visited each area at least once every three weeks and spent 100 hr in the field from August 1960 through February 1961. Skins of jays collected are in the collection of the Department of Zoology, University of Arizona. Stomachs were immediately injected with a mixture of formalin and 70 per cent alcohol and analyzed later. Plants collected in all areas were identified with the standard references, Kearney and Peebles (1951) and Benson and Darrow (1954).

THE STUDY AREAS

In southeastern Arizona, oak woods envelope the hills from 4000 to 6000 ft. Shreve (1915) subdivides the oak woodlands or encinal into two types. Closed encinal occurs in the higher elevations; it is composed of tall dense live

oaks with occasional junipers. Open encinal occurs at lower elevations. It grades gradually into grassland at still lower elevations (Lowe 1961). Occasionally oak chaparral occurs in small stands within the open encinal. Much of the oak cover of the Santa Catalina Mountains, the northernmost of the ranges in which I worked, is transitional between open encinal and shorter, denser oak chaparral. To the north, oak chaparral replaces encinal in the 4000–6000 ft zone. The considerably taller encinal formation continues southward through Sonora, México, south of the range that Scrub Jays frequent in the winter. Above the closed encinal, pine-oak woodland occurs and either grassland or a yucca-agave-sotol association predominates below the open encinal (oak-grassland). Running through the oak woods are stream beds with associated riparian woods, which often extend below the lower limit of oaks and at times draw jays to lower elevational habitats such as mesquite thickets. For a detailed discussion of southeastern Arizona faunal formations see Lowe (1964).

The three jays most often frequent the oak-grassland with occasional riparian stands and in this zone I conducted my study. The large stretches of grass are predominantly of the genera *Bouteloua* and *Hilaria*. A rather uncommon shrub element is composed of *Prosopis*, *Arctostaphylos*, *Rhamnus*, *Celtis*, *Mimosa*, *Acacia greggii*, and *Rhus ovata*. These shrubs, plus *Quercus turbinella* and *Q. emoryi*, are more prevalent in the transitional chaparral-open encinal of the Santa Catalina Mountains. The dominant trees of the oak-grassland are *Quercus emoryi*, *Q. oblongifolia*, and *Q. arizonica*. *Pinus cembroides* and *Juniperus deppeana* are scattered among the oaks. The general aspect of the habitat is a parkland of scattered trees, 20–40 ft high, and infrequent shrubs over open grassy hills (fig. 1). On the steep slopes grow denser stands of shrubs and stunted trees which in some places approach chaparral conditions. The grass is rarely high, because of overgrazing. The ground has little topsoil; sand and small rocks are common throughout the habitat.



FIGURE 1. Typical oak-grassland habitat along Box Canyon Road, Santa Rita Mountains, 20 November 1961.

SEASONAL MOVEMENTS

Occasionally during the breeding season Mexican Jays traverse the oak-grassland where it adjoins their breeding zones of closed encinal and pine-oak woodland. After the breeding season they remain within a few miles of their breeding habitat (Hardy 1961). In late August flocks of Mexican Jays first wander freely over the oak-grassland near their breeding environment higher in the mountains. Eleven of the 15 Mexican Jays collected during the winter in the oak-grassland were adults, according to the criteria of Pitelka (1945). Thus these flocks are composed of a majority of adults with some first-year birds. These individuals may be grouped the same as during the breeding season (Hardy 1961).

Most Steller Jays wintering in this habitat probably descend from the adjacent mountain ranges, but occasional dark specimens suggest the presence of Utah or Colorado populations (Phillips et al. 1964). These darker Steller Jays sporadically invade southern Arizona and even descend to the desert floor. Winter 1960–1961 was such an invasion period when large numbers of Scrub and Steller Jays wintered about the city of Tucson. A few of the Steller Jays were darker northern birds. However no disproportionate number of Steller Jays wintered in the oak-grassland that year compared with the numbers present the following winter. Steller Jay flocks are usually first found in the open encinal in late September.

Although the oak-grassland is not part of the breeding habitat of any jay, scattered pairs of Scrub Jays nest where chaparral conditions exist, especially in the Santa Catalina Mountains. Scrub Jays must move into the oak-grassland from the north, as far too few birds breed in the surrounding pockets of chaparral

to account for the numbers wintering each year, except possibly for the Santa Catalinas. Probably many Scrub Jays move south from the extensive chaparral of central Arizona. As with Steller Jays, Scrub Jays from breeding areas north of Arizona are darker (Phillips et al. 1964); a few of these have been recorded in Arizona during flight years. During the winter 1960–1961 a few darker northern forms were collected, but most were the paler Arizona form. Few Scrub Jays were observed in the open encinal before early September, although banded immature Scrub Jays began to wander from a study site at the southern range of chaparral in the northern foothills of the Santa Catalina Mountains in early August (Westcott, unpublished).

Unlike the Mexican Jays wintering in the open encinal, my specimens show that the other two species are represented only by first-year individuals. Pitelka (1951) states that most specimens he examined from nonbreeding ranges of the Scrub Jay in New Mexico and Colorado proved to be first-year birds. To my limited knowledge no adult Scrub Jays have been collected in strictly nonbreeding locales of southeastern Arizona. Separate flocks of Scrub and Steller Jays probably are formed during the fall when they first enter the region, and break up in the spring when the birds leave.

The movement of Scrub and Steller Jays to southern Arizona represents dispersal (Pitelka 1951); the net result is dispersal of young from their nest site to the place where they later breed. This winter movement by Scrub Jays would allow them to investigate a wide variety of terrain before their first nesting attempts (Johnston 1961). One possible result of a large number of dispersing birds exploring the territory is the occupation of most isolated pockets of suitable breeding habitat as is seen in scattered small breeding groups of Scrub Jays on isolated chaparral-like hillsides throughout southeastern Arizona and into northern Sonora. Conceivably some darker northern forms might settle to breed if they found suitable habitats. The scrub habitats selected by Scrub Jays in Utah and Colorado differ from Arizona chaparral, especially in plant species composition, and the northern birds probably have to return north before they find suitable habitat. There is probably some site tenacity for their breeding locale by southern Scrub Jays already breeding in such isolated pockets of suitable habitat. Thus if a northern bird did attempt to select a breeding site in the south, the site

would probably already be filled by the much more common southern form.

WINTER FLOCKING BEHAVIOR

Most jays are gregarious and each species often forms large flocks when not breeding, but little is known about interspecific flocking. In my study areas Mexican Jays were most common, then Scrub Jays, and Steller Jays were least abundant. Over most sites approximately a 5:2:1 ratio of Mexican to Scrub to Steller Jays prevailed.

Mexican Jays almost always traveled and fed in flocks of 15–25 birds. When feeding, the flock members were often widely dispersed. They normally bunched together only when excited, when rapidly moving about, or when at a plentiful food supply. My observations agree with Brown's (1963) statement that Mexican Jays, unlike Scrub and Steller Jays, congregate at a choice food supply near each other, often within a few inches. Mexican Jays spend extended periods feeding quietly and often the flocks roam, making little if any noise. It is amazing that a large, spread-out flock can move off in concert with little apparent signaling to one another. The flock organization may be maintained by their varied subdued conversation calls, as outlined by Marshall (1957), or they may keep visual contact with other flock members.

Sentinel birds perched on top of trees do warn the flock of imminent danger (Hardy 1961). Possibly the mere act of the sentinel flying down from its perch, even without a call, acts as a visual stimulus for flock movement. In flight these jays produce a characteristic "clop-clop" noise with their wings. Although not audible for very far, it may serve as an additional coordinating stimulus informing flock members of movement.

The flocking behavior of the Scrub Jay is similar to that of the Mexican Jay, but there are a few differences. Scrub Jays are not so gregarious; they usually travel in flocks of 5–15, and occasionally as individuals. Scrub Jays are more vociferous than Mexican Jays, and when moving about, these flocks tend to be extremely noisy. But they can remain as silent as the Mexican Jays and equally as difficult to observe. Scrub Jays also move in concert without any vocal stimulus. They are extremely shy and difficult to approach. Unlike Mexican Jays, they do not respond to odd noises. They also often have, perched above the flock, a sentinel that notices the approach of intruders at a considerable distance. A single warning call by the sentinel is enough to alert the flock.

Possibly Scrub Jays do not cover as much ground as Mexican Jays in their daily search for food.

The Steller Jay in its normal habitat of tall coniferous forest regularly lives in large flocks during the winter, but in oak-grassland they travel in pairs or small flocks of 4–8 birds; rarely is a larger group seen. In oak areas in the fall and winter, Steller Jays often associate with a larger flock of Mexican Jays and travel in their company. Such a flock is not really mixed, as Marshall (1957) observed in the pine-oak woodland; when Steller Jays associate they usually remain as a separate group to one side or follow behind.

While feeding, the two groups remain close but separate. When they occasionally mix, no conflicts occur but Steller Jays give way to Mexican Jays when the latter approach them. This association may satisfy some urge on the part of the Steller Jays to form a large flock, for in the pine-oak woodland where they are more numerous, they travel in large flocks of conspecific birds and do not normally accompany Mexican Jays. Brown (1963) noted that Mexican Jays dominate Steller Jays within the pine-oak woodland in February. Occasionally he found the two feeding together, but saw no association when the flocks moved about. As with the other species, Steller Jays also can move off after a flock that has given no noticeable vocal warning of movement even if that flock happens to be of a different species, such as Mexican Jays.

Marshall (1957) reports that Mexican and Scrub Jays remain separate when in the same area, and my observations substantiate this. These two species rarely travel in company, but at times their paths cross and for a while they appear to be associated. When they move on, the Scrub Jays go one way and the Mexican Jays another. I never saw conflicts between Mexican and Scrub Jays. Neither one appears to dominate the other, but they apparently never come closer together than a few feet.

Scrub and Steller Jays rarely come together. When they do, occasional conflicts arise. Twice I noted Scrub Jays chase away Steller Jays, but one does not appear to search out the other.

The infrequent mixed flocking occurs mostly at food concentrations. Possibly one flock, concentrating its feeding at one site, attracts the attention of flocks of other species. Occasionally where food such as acorns is plentiful under one tree, all three species feed at once. In Gardner Canyon on three occasions I put

pieces of bread and milo seed in various spots which I had never before baited. A few Mexican Jays quickly located the food. No special calls or other sign stimuli that I could discern were given, but within minutes up to 10 Mexican Jays and usually a small group of Steller Jays arrived. Soon Scrub Jays joined and carried off food. On each occasion all three species were present within half an hour after the first had located the food. At such an artificial food concentration a small group of Mexican Jays fed and flew off to a nearby tree. Then a few Scrub Jays moved in. The Steller Jays were wary and dashed in and out rapidly after the other jays had left. Thus, while the birds do not normally feed near each other, they do gather at a food supply, yet retain their separate flock structure.

The normal spatial relationship present among these three jays is flocks of one species, not mixed flocks. At times the three species are found intermixed at an especially abundant food source, but the fact that they tend to isolate themselves is evident when one shoots into a seemingly mixed assemblage. All the Scrub Jays fly off in one direction, the Mexican Jays in another, and the Steller Jays in a third (occasionally the latter follow a flock of Mexican Jays).

An interesting case of mixed flocking was observed during the passage of a large aggregation of Piñon Jays (*Gymnorhinus cyanocephala*) through the open encinal. These birds are very gregarious; often flocks of 50–100 individuals travel in a tight noisy group, constantly sounding like a flock of miniature crows. From September to December 1961 a large-scale invasion of Piñon Jays occurred throughout the encinal regions of southeastern Arizona (Westcott 1964). Thousands of Piñon Jays roamed through the mountains. Often Mexican, Scrub, and Steller Jays followed at the rear of these large flocks as the Piñon Jays trooped through the oaks. Possibly the other jays were first attracted by the constant "cawing" of the Piñon Jays, but the color, general jay shape, and especially the continual movement probably induced the other jays to follow along for a mile or more. Individual Piñon Jays searched for food while the flock was moving along, but the other jays did not attempt to feed while associated.

During this "following" behavior, the three species still retained their separate flock structure, but the attraction of the fast-moving, noisy Piñon Jays allowed for a closer approximation of mixed flocking. The separate species flocks were in close parallel to each other,

sometimes criss-crossing one another's path and at times flying intermixed. Finally the Piñon Jay flock moved far enough ahead of the other jays so that their "following" behavior lessened and they gradually slowed down and went their separate ways.

FEEDING BEHAVIOR

As these jays are similar in bill and foot structure (Ridgway 1904), and all three occupy the same winter habitat, it is not surprising that they use the same type of food and obtain it in the same manner. Mexican Jays usually feed beneath the oaks, but in the open encinal they often range far into open grass areas. Their feeding technique is to pry with their bills under small twigs, leaves, and small stones. Marshall (1957) saw these jays dig several inches into the moist humus in the pine-oak woodland. In the considerably drier oak-grassland I rarely saw the jays dig, but they did explore under leaves, using a sweeping movement of the bill as Marshall described, and pick seeds and insects from under these objects and from the surface. At times jays fly after large insects but usually do not chase insects they flush. Mexican Jays have been noted hawking for insects from trees and over canyons (Marshall 1957; Hardy 1961). The other two species hawk less frequently. Sometimes, if seeds are plentiful, the Mexican Jays concentrate their search on a restricted vicinity under a tree; generally, though, they search over a large area.

They swallow small food items at once but carry larger ones to a tree or rock to peck them apart. A few strong pecks usually open most nuts or break up large insects. Mexican Jays also search through oak trees for seeds and insects, but feed mainly on the ground (Hardy 1961; Brown 1963).

Scrub Jays use the same feeding techniques, but remain closer to the trees and shrubs than the other two species, and do not wander into the open terrain as often. Scrub Jays feed while perched, as do Mexican Jays, but they perch on rocks below the trees and in the shrubs more than in the taller trees. Scrub Jays in Arizona store food but seemingly much less frequently than the Scrub Jays of southern California that store food habitually. This difference may reflect the fact that the southern California Scrub Jay population is non-migratory (Miller, pers. comm.), while the Scrub Jays wintering in Arizona oak-grassland are transients and will leave for permanent residence elsewhere. Yet the breeding birds

TABLE 1. Stomach contents of three species of jays collected in the oak-grassland.

Food item	Scrub Jay		Mexican Jay		Steller Jay	
	n ^a	% ^b	n	%	n	%
Insects:						
Coleoptera						
Tenebrionidae	2	5	5	8	3	7
Scarabaeidae	2	4	2	4	0	
Cerambycidae	0		0		1	3
Carabidae	1	1	2	2	2	2
Curculionidae	1	3	2	2	0	
Elateridae	1	3	0		0	
Unidentified	4	12	5	13	4	16
Lepidoptera						
Saturniidae	0		1	2	0	
Arctiidae	0		1	1	0	
Pyrilidae	0		0		1	1
Unidentified	2	3	1	1	2	2
Hymenoptera						
Formicidae	2	2	2	2	3	2
Unidentified	1	1	2	2	1	2
Orthoptera						
Acrididae	2	2	1	1	0	
Unidentified	1	1	2	1	1	2
Hemiptera						
Pentatomidae	0		0		1	2
Neuroptera						
Myrmeleontidae	0		0		1	1
Average animal material	37		38		40	
Vegetable:						
Oak acorns	11	34	12	38	9	38
Juniper seeds	2	5	5	6	1	2
Manzanita-size seeds	7	9	5	4	3	4
Small herbaceous seeds	4	2	3	1	1	3
Grass seeds	6	4	7	3	2	4
Average vegetable material	54		52		51	
Grinding material:						
Pebbles	14	7	15	7	10	8
Sand	7	2	5	3	2	1
Average grinding material	9		10		9	
Total number of stomachs	14		15		10	

^a Number of stomachs containing a food item.
^b Per cent of total contents for species made up by particular food item.

in Arizona chaparral also store food less commonly than the California birds.

Steller Jays feed in the same manner as Mexican Jays and wander over the same area. They search the oaks and, more than the Mexican Jays, utilize perches in the trees for pecking food apart.

Stomach contents were studied in 14 Scrub, 15 Mexican, and 10 Steller Jays collected between 5 November and 10 January in the oak-grassland. An attempt was made whenever possible to collect the three species in approximately the same place and at the same time.

The quantitative analysis of the stomach contents (table 1) is based on an estimation,

for it is difficult to measure the volume critically when the contents are broken up and partly digested. From the percentages for average animal, vegetable, and grinding material and from individual food items eaten per jay species, it is obvious that all consume the same food in about the same ratios. No jay species selects one food item more than any other jay. Vegetable material is important for all three species, but they also consume much animal material. The winters are mild enough to keep insects, especially beetles, active. Bent (1946) outlined the omnivorous habits of jays.

It was obvious that jays in this oak area selected acorns as a staple; almost all specimens had eaten them. Brown (1963) did not find Mexican Jays locating acorns in February within the pine-oak woodland, but at least through mid-winter jays in the oak-grassland had a considerable supply of acorns. Marshall (1957) noted that Mexican Jays showed a preference for oak areas, perhaps in response to a desired acorn supply.

Next in importance were ground-dwelling beetles of several families, from 7–20 mm long. The lepidopterans were mainly 8–10 mm and were larval forms except for a few adult moths. The seeds were a problem to identify, and usually the best that could be done was to put them in a size class. Though partial to acorns, the jays ate almost any medium or large seeds usually ignoring numerous small seeds of grasses and herbs. The three jays generally selected food ranging in size from 7–25 mm. Jays swallowed pebbles and sand to help grind food. The absence of vertebrate remains is obvious; probably the winters are cold enough to keep lizards under cover.

No spiders were found in any stomach although spiders were extremely common in both summer and winter, especially under small rocks and leaves. It is possible that spiders were ground up and digested so rapidly that I was unable to recognize them or that post-mortem digestion left no recognizable parts. Van Koersveld (1951) emphasized that stomachs must be fixed at once, and that I attempted to do. Bent (1946) reported that spiders were occasionally found in stomachs of Scrub and Steller Jays. If these jays are rejecting spiders, feeding experiments should resolve the question.

DISCUSSION

These wintering jays utilize their shared range with similar strategies which tend to bring them into contact. Interspecific conflict has

been minimized in several ways. There are minor differences in species utilization of the shared oak-grassland habitat, which probably relate to ecological differences in their specific breeding habitats. The Scrub Jays remain closer to the dense shrubs, the Steller Jays spend more time in larger trees, and the Mexican Jays roam farther into the open. Their preference for conspecific feeding is likely a carry-over from their feeding during the breeding season when the birds are isolated. The Scrub and Steller Jays represented here are first-year birds that probably have not previously come in contact with other species of jays; they aggregate separately as when in spatial isolation.

There is a slight tendency towards interspecific flocking when the flocks cross paths; these jays are relatively tolerant of each other's presence. Instead of freely mixing and possibly fighting, a minimal distance of several feet is normally present between jays. This minimal distance is easily maintained for the birds retain separate flock structures even when attracted together. Of course, their separation could be viewed as a result of past competition.

Even if these jays do not normally mix, they respond to other jay species' warning and food location abilities. Mexican Jays twice attracted the attention of both Scrub and Steller Jays to the presence of a bobcat (*Felix rufus*) in Gardner Canyon. The three jays chased the cat for 15 min in one big noisy flock and then gradually separated. As stated above, the chance find of a food source attracts not only other members of the finder's flock, but also other jay species in the area. Apparently the birds respond to a common pattern of signals: similar size, coloration, quality of voice, and types of calls.

Moynihan (1960) suggested that the black and white pattern of magpies may promote intraspecific recognition for individuals desirous of flocking. He regards the tendency of many birds to follow others in flight as an important factor in maintaining flock stability. His hypothesized specific "mobility drive" in particularly gregarious or constantly moving species might be present in the highly gregarious Piñon Jays. In the oak-grassland their noisy congregation provides a visual and auditory stimulus that attracts other jay species with such an appeal that they are dragged along for a short time at a faster rate than they normally travel.

The Piñon Jays, in Moynihan's (1962) terminology, might act as a "passive nuclear

species" which attracts the attention and presence of other jays as "occasional attendant species." This association is of a transitory nature; after a few miles the jays drop back, unused to the rapid pace of the Piñon Jays. This response by the three species of jays toward the noisy and visually obvious Piñon Jays again suggests that the Mexican, Scrub, and Steller Jays recognize a common "jay-pattern": blue, medium size, and noise. This recognition lends itself to increased predator perception and food discovery, but has not yet advanced to constant mixed flocking as commonly found among temperate fringillids and many tropical passerines.

Invading flocks of Clark Nutcrackers (*Nucifraga columbiana*) did not elicit a similar reaction among the three jays. Although nutcrackers are often as noisy as Piñon Jays, possibly the pattern of black, gray, and white is sufficiently different that discrimination is possible.

SUMMARY

Scrub, Mexican, and Steller Jays were studied in a nonbreeding habitat of oak-grassland in southeastern Arizona during the fall and winter. Flocks of first-year Scrub and Steller Jays and flocks of combined first-year and adult Mexican Jays freely roamed in this area. The spatial distribution of these birds is in conspecific flocks that move through the same habitat, come together, and part according to their original units. Steller Jays tend to associate with Mexican Jays but they do not freely intermix. The reaction of these jays to the presence of invading flocks of Piñon Jays is described. The three species use the same feeding techniques and concentrate upon the same food sources. Possible failure to use spiders as food is noted.

The adaptiveness and control of flocking of these jays during the winter is illustrated in several ways. There is some slight ecological separation of these jays in the oak-grassland, probably related to ecologically isolated breeding habitats. Some dominant-subordinant reactions among the species probably reduce fighting when they are close to each other, but normally a minimal distance is maintained that keeps the species apart. A common "jay-pattern" may be recognized by the three species, which may aid in predator recognition and food location and may explain their reaction to large flocks of Piñon Jays.

ACKNOWLEDGMENTS

This study was conducted while I attended the University of Arizona, Tucson, and I wish

to thank Joe T. Marshall, Jr., for supervising my work. I am especially grateful to Anthony Ross for aid in stomach analyses, and O. L. Austin, Pierce Brodkorb, and E. G. F. Sauer for critically examining the manuscript.

LITERATURE CITED

- BENSON, L., AND R. A. DARROW. 1954. The trees and shrubs of the southwestern deserts. Univ. Arizona Press, Tucson.
- BENT, A. C. 1946. Life histories of North American jays, crows and titmice. U.S. Natl. Mus., Bull. 191.
- BROWN, J. L. 1963. Social organization and behavior of the Mexican Jay. *Condor* 65:126-153.
- HARDY, J. W. 1961. Studies in behavior and phylogeny of certain New World jays (Garulinae). Univ. Kansas Sci. Bull. 42 (2):13-149.
- JOHNSTON, R. F. 1961. Population movements of birds. *Condor* 63:386-389.
- KEARNEY, T. H., AND R. H. PEEBLES. 1951. Arizona flora. Univ. California Press, Berkeley.
- LOWE, C. H., JR. 1961. Biotic communities in the sub-mogollon region of the inland Southwest. *J. Arizona Acad. Sci.* 2 (1):40-49.
- LOWE, C. H., JR. [ed.]. 1964. The vertebrates of Arizona. Univ. Arizona Press, Tucson.
- MARSHALL, J. T., JR. 1957. Birds of the pine-oak woodland in southern Arizona and adjacent Mexico. *Pacific Coast Avifauna*, no. 32.
- MOYNIHAN, M. 1960. Some adaptations which help to promote gregariousness. Proc. XII Intern. Ornithol. Congr., Helsinki, p. 523-541.
- MOYNIHAN, M. 1962. The organization and probable evolution of some mixed species flocks of neotropical birds. *Smithsonian Misc. Coll.* 143, no. 7.
- PHILLIPS, A. R., J. MARSHALL, AND G. MONSON. 1964. The birds of Arizona. Univ. Arizona Press, Tucson.
- PITELKA, F. A. 1945. Pterylography, molt, and age determination of American jays of the genus *Aphelocoma*. *Condor* 47:229-260.
- PITELKA, F. A. 1951. Speciation and ecologic distribution in American jays of the genus *Aphelocoma*. Univ. California Publ. Zoöl. 50: 195-464.
- RIDGWAY, R. 1904. The birds of North and Middle America. U.S. Natl. Mus., Bull. 50(3):252-374.
- SHREVE, F. 1915. The vegetation of a desert mountain range as conditioned by climatic factors. *Carnegie Inst. Wash. Publ.* 217:1-112.
- VAN KOERSVELD, E. 1951. Difficulties in stomach analysis. Proc. X Intern. Ornithol. Congr., Uppsala, p. 592-594.
- WESTCOTT, P. W. 1964. Invasion of Clark Nutcrackers and Piñon Jays into southern Arizona. *Condor* 66:441.

Accepted for publication 19 November 1968.