

Burton on Sable Island. We thank several students and others who helped with the field work on the Magdalen Islands. Finally, we thank the amateur and professional ornithologists who reported observations or recoveries of our marked shorebirds; without their collaboration, most of these results would have not been obtained. We are grateful to Marlène Valcin and France Guimont for helping with preparation of the manuscript.—RAYMOND McNEIL and JEAN BURTON, *Centre de Recherches écologiques de Montréal, 4101 est, rue Sherbrooke, Montréal, Québec, H1X 2B2, Canada. Accepted 14 April 1976.*

Flocking and foraging behavior of Brown Jays in northeastern Mexico.—The flocking and foraging behavior of the Brown Jay (*Psilorhinus morio*) was studied from 29 December 1975 to 9 January 1976. Observations were made in a climax evergreen forest along the Río Corona and the Río Pilon, Tamaulipas, and a tropical deciduous forest at El Salto, San Luis Potosí, Mexico.

Brown Jays live in family groups (Sutton and Pettingill, *Wilson Bull.* 54:213-214, 1942; Brown, *Am. Zool.* 14:63-80, 1974). At all 3 study sites, the Brown Jay was the first bird species seen or heard each morning. The daily activity of the family groups began about 30 min before sunrise with a seemingly spontaneous burst of calling and rapid flight through the canopy. These flights were interrupted by short (5 sec to 2 min) intervals of complete silence during which the jays hopped about, poked at one another, and preened, but did not forage. These activity patterns were similar to the morning "rallying" as described for a Piñon Jay (*Gymnorhinus cyanocephalus*) flock by Balda et al. (*Auk* 94:in press), who felt that these activities may serve to attract group members and play a role in social cohesiveness.

Foraging began after the initial rallying of a Brown Jay group, with groups ($n = 9$) ranging from 8 to 15 individuals. Adults and juveniles, distinguishable by bill color (Skutch, *Auk* 52:257-273, 1935; Selander, *Auk* 76:385-417, 1959), separated by mid-morning. Significant differences in group size, reflecting this break-up (Fig. 1), were shown using Duncan's New Multiple Range Test (Steel and Torrie, *Principles and Procedures of Statistics*, McGraw-Hill, Inc., N.Y., 1960). Morning (08:00) and evening (18:00) group sizes were significantly different from the mid-morning size ($P < .05$), and highly significant from later (12:00, 14:00 and 16:00) group sizes ($P < .01$).

During late mornings and afternoons, single adults were observed foraging, preening, and resting quietly. When disturbed by human activity, the adults either seemed to ignore the disturbance, or moved silently away. The juveniles, however, were never observed alone, but would remain in 1 or 2 groups (4-6 individuals), flocking throughout the day. Between periods of foraging and general body maintenance, the juvenile Brown Jays would move through the canopy loudly calling. As sunset approached, the adults and juveniles rejoined; this is reflected in the increase in group size (Fig. 1). Pre- and post-roosting activities were similar, with loud calling (by all members) and a diminishing number of flights as night approached and roost sites were selected. All group members roosted in the canopy of the same or adjacent trees.

By spending the morning and evening with the more experienced adults, the juveniles may be greatly increasing their survival chances by direct observance of adult behavior. In the absence of adults, these juvenile groups may afford increased predator protection and foraging success in contrast to a juvenile foraging alone. This may imply a greater dependence on learning in Brown Jays as compared to jays that do not remain with their parents for extended periods, such as the Blue (*Cyanocitta cristata*) and Steller's (*C. stelleri*) jays (Brown op. cit.). Cully and Ligon (*Auk* 93:116-125, 1976) considered

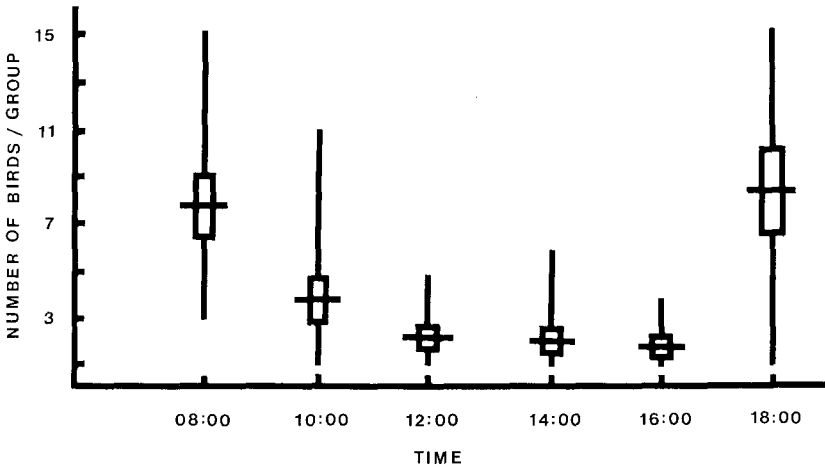


FIG. 1. Number of Brown Jays per group at selected daily time periods at Rio Corona, El Salto, and Rio Pilon, Mexico, with range, mean, and 1 standard error (bar) on either side of the mean (number of groups = 51).

this while studying the Mexican Jay (*Aphelocoma ultramarina*). Brown (op. cit.) suggests that Brown Jays raise a single brood per year and have a high nesting success. Further, the high nesting success of Brown Jays may result from the presence of juvenile nest helpers. Woolfenden (Auk 92:1-15, 1975) found that nest helpers enhance the reproductive efforts of breeding Florida Scrub Jays (*Aphelocoma c. coerulescens*), whose social system resembles that of the Brown Jay. In the non-breeding season the separation of adults and juveniles for part of the day may minimize competition for available food resources or may be an indication of the juveniles' lack of foraging efficiency and thus their need to feed longer than adults. Communal roosting and morning and evening rallying would serve to maintain the social structure of the group during the non-breeding season.

Certain data on foraging behavior were recorded for 61 Brown Jays. Only 6.5% of their daily activity was on the ground, and then only of short duration for capturing a food item. Foraging height at El Salto and the Rio Pilon averaged 75-80% of tree height (\bar{x} tree height = 13.3 m, $n = 32$; and $\bar{x} = 11.9$, $n = 29$, respectively; no detailed notes on foraging heights were taken at the Rio Corona). No significant correlation was found between foraging height and air temperature, humidity, cloud cover, or wind speed and direction. However, foraging height declined significantly as the day progressed at both El Salto ($r = -.551$, $P < .01$, $n = 32$) and the Rio Pilon ($r = -.583$, $P < .01$, $n = 29$). Upon morning arousal the canopy roosting Brown Jays would be able to directly use the sun's warmth by remaining in the tree tops and/or be better able to locate food. Although we found no direct correlation between foraging height and temperature, the importance of temperature cannot be discounted as these were recorded beneath, not above nor in the canopy. Therefore, as the day progressed and the sun rose higher, the jays may have been forced down into the shaded areas beneath the canopy either to avoid thermal stress, or in response to movement of their food supply. Pearson (Condor 73:46-55, 1971) noted

such a downward movement during mid-day by much of the avian community in a tropical dry forest of Peru, and attributed these to high temperatures and/or insect movement. If Brown Jays are not responding to heat or insect movement, their downward shift in height may be a result of a movement to a preferred foraging zone after initial canopy rallying.

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Do more birds produce fewer young? A comment on Mayfield's measure of nest success.—Fretwell (Populations in a Seasonal Environment, Princeton Univ. Press, Princeton, NJ, 1972) has considered the effect of nest density on nesting success of Field Sparrows (*Spizella pusilla*). He used the method of Mayfield (Wilson Bull. 73:255-261, 1961) to calculate a daily mortality rate and from this the overall nest survival rate. Fretwell concluded that the nesting success rate decreases as density increases. A closer look at the data, pictured in Fretwell's Figure 44, suggests that not only does the survival rate decrease with increasing density but, in fact, the decrease in survival rate is actually so great that at higher densities the larger total number of breeding adults would produce a lower total number of young than would a smaller number of less crowded adults. The data given are not sufficient to draw this conclusion explicitly and Fretwell does not do so, but it is implicit in his schematic Figure 45 which shows overall nest survival decreasing very rapidly as nest density increases.

It is theoretically possible that more birds might produce fewer young but this seems sufficiently improbable to require an examination of the method used to estimate nesting success. Examination shows that Mayfield's method of estimating nesting success may be biased if not all nests have the same chance of success. This bias will be negligible for low or moderate nest mortality but for high nest mortality it may substantially exaggerate nest mortality.

Mayfield's measure of nesting success was designed to eliminate the bias in earlier methods of estimating nesting success. In using Mayfield's method, first a daily nest mortality rate, p , is estimated by dividing the number of nest failures by the number of nest-days at risk. Then the overall survival rate is calculated to be $(1 - p)^n$, where n is the nest lifetime. Mayfield's method assumes that the risk is the same for all nests and for all days. If, in fact, different nests have different probabilities of surviving then Mayfield's method will produce a biased estimate of the nesting success rate. In general, the estimated success rate will tend to be less than the actual success rate if the nests differ.

There is some evidence that nests may actually differ in survival probability. Nice (Trans. Linn. Soc. N. Y. 4:1-247, 1937) in her work on Song Sparrows (*Melospiza melodia*) observed that well-concealed nests are less likely to be destroyed than badly-concealed nests. Baptista (Auk 89:879-882, 1972) conjectured that the parasitism of White-crowned Sparrows (*Zonotrichia leucophrys*) by Brown-headed Cowbirds (*Molothrus ater*) that he observed in San Francisco may have been due to the suboptimum habitat which didn't offer the White-crowns adequate cover. Krebs (Ecology 52:2-22, 1971) observed that Great Tits (*Parus major*) nesting in hedgerows had less success than birds nesting in woodlands.

The bias in Mayfield's procedure when nests have different survival probabilities may be illustrated in a simple example. Assume that a nesting population consists of birds of