nor did she make any apparent movements to attract the male.

Immediately after giving the last of several head-jerk displays, the male strutted from the front of the female around to a position just behind her. The female then responded by crouching low on the ground with her back to the male. Her wings were outstretched and held slightly above the level of the back, with the primaries spread widely apart. The body feathers of the hen were somewhat ruffled in appearance and the tail was closed and shifted over to one side to expose the cloaca. This response is very much like the receptive posture of female Sage Grouse (*Centrocercus urophasianus*).

The male, once the female had assumed the receptive posture, stepped on her back and grasped the feathers of the back of her head in his beak. The wings of the male were extended to the ground on either side of the female, probably to maintain balance. His tail was lowered in an attempt to make cloacal contact. The male then made pushing movements with his feet against the upper back region of the female, with his neck bent forward and pulled down so that his throat was nearly on his breast. Once cloacal contact was established, the treading movements on the female's back continued for approximately 10 sec, after which the male dismounted. He then strutted away in the same vigorous manner displayed in precopulatory behavior.

The female after copulation exhibited postcopulatory behavior similar to that displayed by many hens of the Galliformes (Lumsden, 1968, op. cit.). Once the male had stepped off her back, the female moved forward several feet with most of her feathers ruffled, shaking them vigorously as if she had taken a dust bath. Her tail was alternately spread and closed, and her head was in a more vertical position than it was in the receptive posture. The feather-shaking lasted about 15 sec, after which the female spent a short time preening.

The male continued to show a high degree of response to sexual stimuli after copulation; i.e., he strutted vigorously, gave several challenge calls, and twice performed display-flights in response to recorded female calls. The female showed no further response.

Accepted for publication 11 December 1970.

POST-BREEDING NEST CAVITY DEFENSE IN PURPLE MARTINS

J. C. FINLAY
Site 9, R. R. 7
Edmonton, Alberta, Canada

During studies of Purple Martin (*Progne subis*) activity, I noted that behavior similar to that of nest cavity defense in the spring (Allen and Nice 1952; Johnston and Hardy 1962) appeared to be repeated in late summer. This activity, which I called "post-breeding," I first observed at Edmonton in 1963. That season several subadults participated in intense activity in and around a nest box for about a week in early fall. The same procedure was noted in this colony the next season. In 1965 and 1966 this activity of entrances and departures at nest boxes was recorded with electronic equipment. In 1966 a new phase was noted: at least three subadult males each attracted females that assisted in defending their cavities for several days.

Based on data for 14 males, this final stage in the breeding cycle lasted 5.9 $\pm$ 4.6 days with a range of 1–19 days. Activity during the post-breeding stage was quite intense (fig. 1). There appeared to be two daily peaks of activity, morning and afternoon; the former was generally greater. A comparison between the activity when martins first arrived in the spring and during the post-breeding stage of late summer showed that entrance–departure activity of both stages was of the same intensity.

As two earlier workers on Purple Martins made only brief mention of post-breeding activity (Olmstead 1955; Johnston and Hardy 1962), I submit a summary of my notes. Post-breeding activity began in the early morning with males, usually subadults, arriving at the nest boxes, either singly or in small flocks. Some individuals entered the nest cavities without hesitation; others, which I presumed were newcomers, hesitated before entering. The occupant of a cavity defended it by making sudden outward lunges from the entrance, or by resting in front of the nest entrance in a manner similar to that described in Johnston and Hardy's (1962) comments on first arrival and my own observations. Birds were continually flying from cavity to cavity. If a new bird arrived, all established males produced a piercing cry and attempted to discourage the newcomer from landing nearby. Few fights and no gathering of nest material were observed during the post-breeding stage. Observation of color-banded birds indicated that previous nest tenants that had fledged young that year did not participate in this stage.

Post-breeding defense activity commenced about mid-July and increased as the season progressed. By the time the last young fledged near the end of July in 1966, 30–40 martins were competing for possession of future nest cavities at one colony. This competition continued for a few days and then ceased by 2 August in both years.

Researchers have reported fall activity for other bird species. Brewster (1925) and Bump et al. (1947) mention fall drumming of Ruffed Grouse (*Bonasa umbellus*). Nice (1937) mentions young resident Song Sparrows (*Melospiza melodia*) taking up territory in their first fall. Morley (1943) summarized the European literature on bird territorial activity in the fall. Peterson (1955) observed recently fledged Bank Swallows (*Riparia riparia*) examining old holes and digging at new ones.

I suggest as a tentative explanation for the post-breeding defense activity in Purple Martins, that it may help to imprint upon participating birds the location of future nest sites. A territory to which they will return the following spring could be learned. Martins have a fairly good homing instinct. Southern (1968) found that 79.8 per cent of the 96 birds used in homing experiments returned over distances of 1–594 miles. Data from birds banded in my studies indicate that martins return each year to nest in the same area. My returns of birds banded as nestlings indicate that they nested 3–10 miles from the colony where they were raised. However, one female I banded as a nestling later nested 85 miles SW of the place where she had fledged.

My observations and others suggest that martins

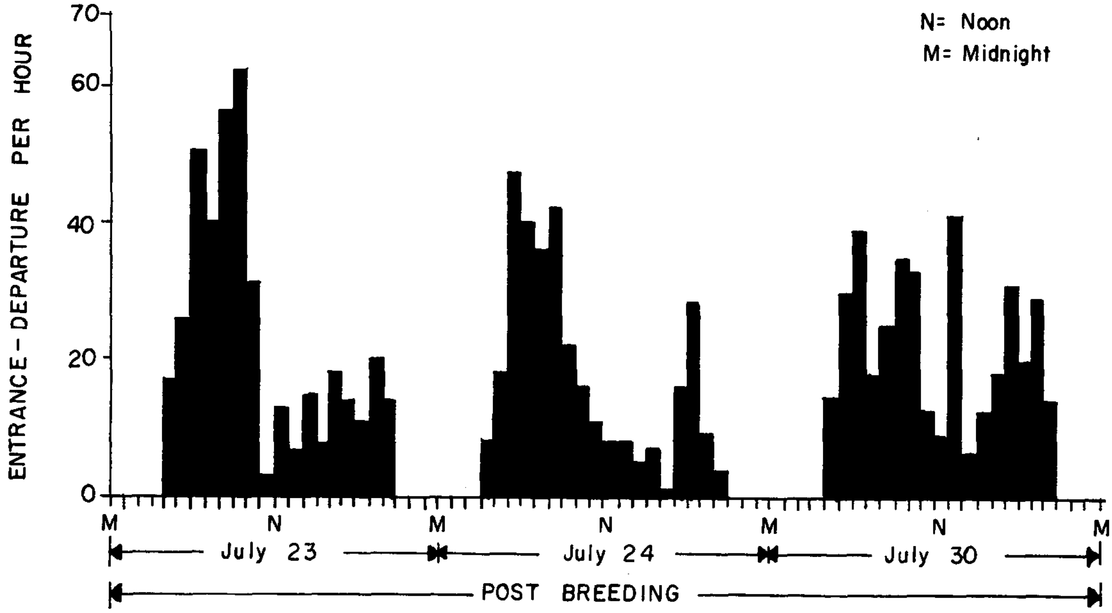

FIGURE 1. Mean hourly entrance–departures of Purple Martins for three days in the post-breeding stage at the end of the breeding cycle. These data, collected in 1966 at Elk Island National Park, involved a yearling male that began defending the cavity 23 July, a female that joined the defense 27 July, and a lone adult male defending the cavity on 30 July.

"remember" the exact location of nest boxes, since in the spring, if the box has not yet been put up, they will flutter around where it was the previous year. Nice (1937) has shown that territorial behavior in the Song Sparrow in the late summer has the function of fixing in the bird an individual territory to which it later returns in the spring. Similarly, Purple Martins may learn the location of available nest sites within a 10-mile radius by post-breeding activity.

LITERATURE CITED

Allen, R. A., and M. M. Nice. 1952. A study of the breeding biology of the Purple Martin (*Progne subis*). Amer. Midland Nat. 47:606–665.

Brewster, W. 1925. The birds of the Lake Umbagog region of Maine. Bull. Mus. Comp. Zool. 66: 276–305.

Bump, G., R. W. Darrow, F. C. Edminster, W. F. Crissey. 1947. The Ruffed Grouse, life history, propogation, management. New York St. Conserv. Dept., Buffalo.

Johnston, R. F., and J. W. Hardy. 1962. Behavior of the Purple Martin. Wilson Bull. 74:243–262.

Morley, A. 1943. Sexual behaviour in British birds from October to January. Ibis 85:132–158.

Nice, M. M. 1937. Studies in the life history of the Song Sparrow. Vol. I. A population study of the Song Sparrow. Trans. Linnaean Soc. New York 4:1–247. (Reprinted in 1964 by Dover Publications, New York.)

Olmstead, R. 1955. Observations on Purple Martins. Kansas Ornithol. Soc. Bull. 6:8–10.

Peterson, A. J. 1955. The breeding cycle in the Bank Swallow. Wilson Bull. 67:235–286.

Southern, W. E. 1968. Experiments on the homing ability of Purple Martins. Living Bird 7:71–84.

Accepted for publication 9 December 1970.

PELLET REGURGITATION BY CAPTIVE SPARROW HAWKS (*FALCO SPARVERIUS*)

THOMAS G. BALGOOYEN[1]

Department of Biological Sciences
San Jose State College
San Jose, California 95114

When ingested by raptorial birds, indigestible materials such as hair, bone, insect exoskeletons, or reptile scales may be regurgitated in the form of pellets. Food habit studies of birds of prey frequently are based on analysis of pellet materials. Table 1 summarizes observations on rates of pellet regurgitation by various raptors, as reported by other authors. Additional variables include the size, weight, and composition of pellets in relation to different kinds and amounts of food eaten. The mechanisms of timing and casting of pellets are not well understood. This paper reports on the rate (duration of time between first ingestion of food and pellet ejection), size, weight, and number of pellets produced after a feeding by captive Sparrow Hawks fed known amounts of different foods.

Four Sparrow Hawks were placed in individual wooden stalls 240 cm high, 45 cm long, and 61 cm deep (fig. 1). Welded wire fabric served as flooring

[1] Present address: Museum of Vertebrate Zoology, University of California, Berkeley, California 94720.