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**Caching by Red-breasted Nuthatches.**—The Red-breasted Nuthatch (*Sitta canadensis*) breeds in boreal forests and erupts southward in winters when its normal food of conifer seeds is in short supply (Larson and Bock 1986). Roberts (1979) remarked that caching is undocumented in such eruptive individuals far from their coniferous forest breeding areas. During the winter of 1985–86, we studied "copying" of food-finding (Krebs 1973) by free-ranging birds of a bark-foraging guild in Ohio. Although Red-breasted Nuthatches are usually absent from the deciduous woodlands of our study area, we encountered the species during a replicate of an experiment (described elsewhere) when three individuals provided us with evidence that caching occurs in birds wintering outside the breeding range.

We made available to color-marked birds of mixed-species foraging flocks a supply of mealworms (*Tenebrio* sp.) hidden in a hollow sapling. The mealworms could be extracted only through a small inconspicuous hole. Dominance relationships within and across species were determined from records of chases and supplanting attacks (Hinde 1952).

Mealworms were taken by three Red-breasted Nuthatches between 09:48 on 31 January and 08:36 on 1 February (Fig. 1). For comparative purposes, we also show the record of mealworms taken by the dominant pair of Carolina Chickadees (*Parus carolinensis*) in the same flock. Carolina Chickadees did not cache mealworms during any of our observations. We confined our analysis of caching to the period between 11:36 and 16:00 on 31 January, when all three nutchatches and both chickadees were removing mealworms. At 11:36, air temperature in the shade was $-3.0°C$, wind velocity 1 m above the ground was 0.7 m $sec^{-1}$, direct solar radiation was 8 mW $cm^{-2}$, and snow depth was 8 cm.

Although we were able to observe the nuthatches caching mealworms in neighboring trees periodically throughout the day, we concentrated most of our attention on the food source

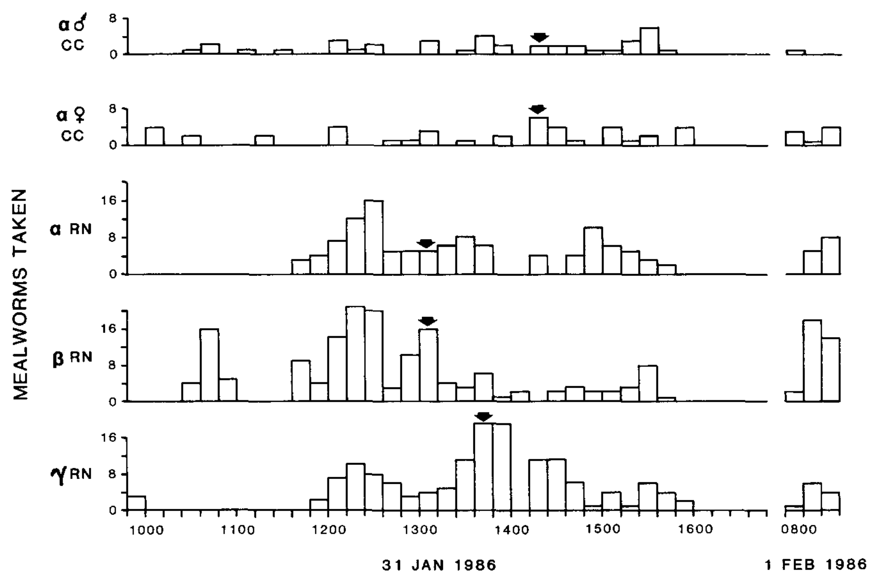

FIG. 1. Mealworms taken from a feeder by 2 Carolina Chickadees (CC) and 3 Red-breasted Nuthatches (RN) on 31 January and 1 February 1986. Medians denoted by arrows in the figure used records from the period between 11:36 and 16:00 on 31 January.

to record the identity of all birds taking mealworms. Thus, we assume that had they not been caching, the nuthatches would have consumed mealworms at about the same rate as the two chickadees. This assumption seems reasonable because the nuthatches (12.0, 11.9, 11.4 g) were similar in mass to the chickadees (10.8, 10.3 g) and, therefore presumably, in metabolic requirements. Although it is true that the act of caching must have involved some additional metabolic cost, we have insufficient data to approximate what that increase might have been. We assume that all mealworms removed by nuthatches over and above the number removed by the chickadees were cached, but we recognize that some of the additional mealworms may have been eaten rather than cached.

During the 22 12-min periods between 11:36 and 16:00 that we oberved the birds, the two chickadees took 36 and 34 mealworms, respectively, while the alpha (male), beta (female), and gamma (male) individuals in the intraspecific dominance hierarchy among the nuthatches removed 107, 186, and 140 mealworms, respectively. The difference between the two species in removal of mealworms was significant (two-tailed $t$-test; $P < 0.05$). Although number of mealworms taken per 12-min period was significantly correlated for the alpha and beta nuthatches (Pearson's $r = 0.69$; $P < 0.05$), correlations between each of these birds and the gamma nuthatch were nonsignificant (Pearson's $r = 0.06$ and 0.05, respectively). The alpha and beta birds each took half the day's total of mealworms by 13: 12, but the gamma nuthatch did not take half its mealworms until 13:48.

Assuming that each nuthatch consumed 35 mealworms during the period (the average for the chickadees) the alpha, beta, and gamma nuthatches, respectively, cached 72, 151, and 105 mealworms in the surrounding woods. These totals amount to a mealworm being cached every 3.7, 1.8, and 2.5 min, respectively, for the three birds throughout the 4.4-h period of analysis. The 1.9-cm-long mealworms averaged 0.86 kcal in energy content (Waite 1986). Therefore, the alpha, beta, and gamma nuthatches cached approximately 61.9, 129.9, and 90.3 kcal, respectively, during the period, or 14.1, 29.5, and 20.5 kcal $h^{-1}$.

These results circumstantially demonstrate a strong tendency for Red-breasted Nuthatches to cache food at a site outside the breeding range. The waning of caching late in the day—shown most clearly by the alpha and beta birds—is consistent with the hypothesis that items of food cached early in the day are retrieved and eaten later on the same day during the hyperphagia accompanying fat deposition (Sherry 1985). Throughout the day, the alpha nuthatch attempted to defend the food source against chickadees and the other Red-breasted Nuthatches. Time devoted to chasing and display may have caused the reduction in this bird's caching below the levels shown by the beta and gamma birds. Any caching rhythm in this species, however, appears subject to modification by proximate circumstances as shown by the gamma bird which cached later in the day than during the most intensive caching period of its dominant conspecifics.

Caching behavior has been shown to be intense in Red-breasted, White-breasted ([*Sitta carolinensis*]; Waite and Grubb, in press), and European ([*Sitta europaea*]; Moreno et al. 1981, B. Enoksson, pers. comm.) nuthatches. As nuthatches adapt readily to life in captivity (Pierce and Grubb 1981; Waite and Grubb, in press), the caching behavior of *Sitta* could be a useful tool for testing models of caching patterns (Stapanian and Smith 1978, Clarkson et al. 1986), memory for locations of caches (Kamil and Balda 1985), and timing of the retrieval of caches (Stevens and Krebs 1986).

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**Age-class differences in the use of food sources by European Starlings.**—The foraging patterns of adult birds often differ from those of juvenile conspecifics. Such age-class differences may be related to the juveniles' lack of skill at a difficult foraging technique (e.g., plunge-diving; Dunn 1972), adult-juvenile competition (Burger and Gochfeld 1983), or because juveniles forage in areas that contain little food (Magrath and Lill 1985).

Age-specific diet differences occur in European Starlings (*Sturnus vulgaris*). While adults continue to feed on soil invertebrates through the summer (Tinbergen 1981), the diet of fully independent juveniles consists largely of plant matter (Feare 1984). Juveniles are less able than adults to locate soil invertebrates (Stevens 1985). The segregation of age classes into different foraging habitats appears to occur only in summer (Feare 1984).

Here I (1) compare the foraging substrates used by adult and recently fledged juvenile starlings during two breeding seasons, (2) present evidence that the food sources used by juveniles often are of poor quality, and (3) speculate that the latter may contribute to the high juvenile mortality during this time of year (Coulson 1960).

*Study areas.*—I established two circular 300-km$^2$ study areas in central New Jersey. Owing to the starling's broad diet (Lindsey 1939), I selected two study areas with different land-use characteristics. The Franklin area, near New Brunswick in Middlesex County, was mostly urban-suburban, with abundant grassland but little agriculture. The Adelphia area, 40 km SSE of Franklin in Monmouth County, was largely rural-agricultural, with less grassland than Franklin.

*Methods.*—I estimated starling populations during weekly roadside censuses along 50 km of established routes in each study area during the breeding seasons of 1983 and 1984. Censuses were begun within 30 min after sunrise and lasted about 3 h. I drove at an average speed of 30 km/h, and stopped often to observe birds. Foraging birds were recorded as adult or juvenile, and each was assigned a foraging substrate, including grassland (managed lawns; unmanaged pastures and meadows); crop fields (mainly soybean, corn, and small grain) in various stages (plowed, planted, mature, harvested, fallow), and human-assisted sources (e.g., bird feeders, garbage pails). I did not assign an age class to flying or resting birds. Censuses began in early June, after first-brood juveniles were observed in the area, and were discontinued in early August after I could no longer use plumage to separate juvenile from adult birds with sufficient reliability. Each two consecutive weekly censuses were combined into biweekly periods to facilitate comparisons with food availability, which was measured every two weeks.

I measured invertebrate density in grassland and growing soybean fields, and grain density in harvested wheat fields. In each study area I sampled three grass fields and three fields of both crop types every two weeks. Grasses were sampled using a grid technique (Ng et al. 1983). The surface, thatch, and soil were searched to a depth of 4 cm, which I judged to be