dent. Her weight (7.7 g) indicated that she was laying. The nest contained 5 unincubated eggs. On 17 May the female was recaptured and weighed 6.3 g. This time she had a definite brood patch and continuously gave distress calls. The nest contained 6 warm eggs. A 20 min observation period on 18 May showed no activity at the nest, and we assumed that the female was incubating. On 24 May a tear was noted near the top of the nest. The nest contained 4 newly hatched, but dead nestlings, 2 unhatched eggs containing nearly fully developed embryos, and 1 cowbird egg showing no sign of development. We saw no adult birds in the vicinity and concluded that the nest had been abandoned. Freshness of the young suggested to us that the nest had been deserted within the past 2 days. It seems likely that the damage to the nest was caused by the cowbird when the egg was deposited, as has been reported for Verdins (*Auriparus flaviceps*) (Friedmann, op. cit., 1963) and for 1 of the cases of parasitism described from British Columbia (Friedmann et al., op. cit., 1977). Desertion may have occurred either in response to the damaged nest or to the presence of the cowbird egg.

Of 54 bushtit nests studied in 1977, this was the only case of cowbird parasitism. That the cowbird egg was deposited so late in the incubation period might off-hand suggest egg-dumping. However, since it was not late in the reproductive period of the species and since this event is not comparable to the well-documented dump-nests of Shining (*Molothrus bonariensis*), and Bronzed (*M. aenus*) cowbirds, it is perhaps better to regard it as a case of faulty timing by the parasite (Friedmann et al., op. cit., 1977). Since cowbirds lay clutches of eggs (Payne, Condor 78:337–342, 1976), a cowbird might resort to an inappropriate nest when not enough host nests are available.

We wish to acknowledge the help of Keith Bergman, Cynthia McCarthy, and Russ Ray with the field work and to thank Cynthia McCarthy, Donald S. Farner, Sievert A. Rohwer, and John C. Wingfield for their comments on this note.—JAN PETER SMITH, *Dept. of Zoology, Univ. of Washington, Seattle, WA 98195, and* RILEY J. ATKINS, *206 N. 41st St., Seattle, WA 98103.* *Accepted 30 Nov. 1977.*

Wilson Bull., 91(1), 1979, pp. 123–126

Effect of food availability on leaf-scratching by the Rufous-sided Towhee: test of a model.—Many emberizine species scratch in leaves with a 2-footed kick to the rear under their bodies (e.g., Hailman, Wilson Bull. 85:348–359, 1973). The number of successive scratches given without a distinct pause (a "bout") was modeled quantitatively, and the model successfully predicted scratching behavior of White-throated Sparrows (*Zonotrichia albicollis*) and Dark-eyed Juncos (*Junco hyemalis*) (Hailman, Wilson Bull. 86:296–298, 1974). Later Hailman (Wilson Bull. 88:354–356, 1976) found that scratching of the White-crowned Sparrow (*Z. leucophrys*) and Fox Sparrow (*Passerella iliaca*) also conformed to prediction. These comparative data suggest that scratching obeys the same rules for all emberizines, although Hailman (1976:356) noted that "a check on the rather different towhees (*Pipilo*) would be desirable." We report our combined data for scratching by Rufous-sided Towhees (*P. erythrophthalmus*) in Tennessee, which include an experimental test by E.H.B. of the model.

The model states simply that the bird scratches until uncovering a potential food item, and that the probability of finding such an item is constant (independent of the number of scratches given previously in the bout). The model predicts that:

$$\log f_s = \log p(s-1) + \log B, \qquad (1)$$

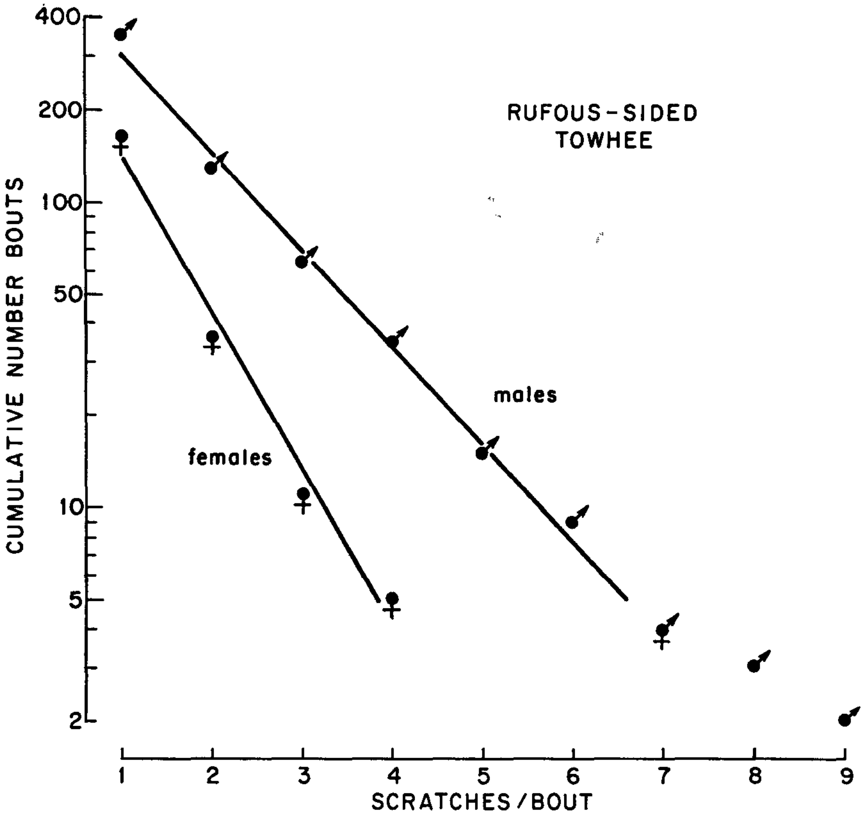

FIG. 1. Cumulative frequency of scratching bouts in male and female towhees. The model predicts linear relationships. (There is 1 data-point not shown for males at 13 scratches/bout; see text for fit of regression lines.)

where f_s is the frequency of bouts having s or more scratches (i.e., a cumulative frequency), p is the constant probability of uncovering food and B is the number of bouts observed. Equation (1) expresses a linear relationship between log f_s and $s-1$, with slope log p (negative because p is fractional) and intercept log B, so that log f_s is inversely proportional to $s-1$ and hence to s. We tested for linearity of the proportionality in both male and female towhees, thereby providing the first comparison of sexes within a species. In addition we experimentally tested the model by changing the probability, p, of uncovering food to see if the slope changed as predicted by eq. (1). The data consist of 381 scratching bouts (296 from males, 85 from females) observed by E.H.B. in Knoxville during the period 12 February to 29 March 1977, and 132 bouts (54 male, 78 female) by J.P.H. in Nashville on 25–27 December 1976. Both sets of data come from suburban lawns in the vicinity of feeding trays, with about 4 towhees present in the area in Knoxville and about 6 birds present in Nashville.

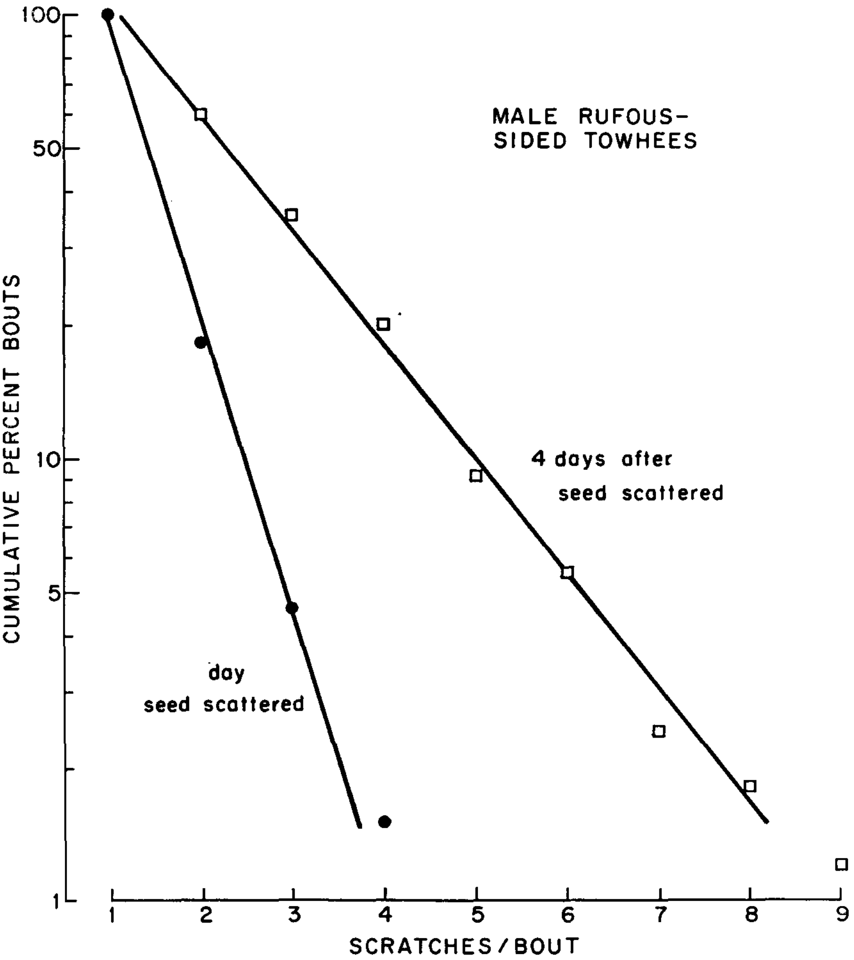

FIG. 2. Cumulative (normalized) frequency of scratching bouts in male towhees under 2 conditions of food-abundance. The model predicts a steeper slope on the day seed was scattered than 4 days afterward. (There is 1 data-point not shown at 13 scratches/bout for the right-hand curve; see text for fit of regression lines.)

Fig. 1, which plots all the data except 1 observation of a bout of 13 scratches by a male, shows that both males and females conform to the predicted linear inverse relation between number of scratches/bout and the cumulative frequency of bouts. The correlation coefficients for the total data are $r = -0.959$ for males and $r = -0.865$ for females. Cumulative frequencies have the annoying property of being much more reliable at higher values than at lower values, where random occurrences such as the 1 bout of

13 scratches by a male can cause considerable departure from linearity. Hence correlations are more meaningful when calculated from distributions that use cumulative frequencies above some arbitrary value that excludes random fluctuations at small sample sizes. When calculated on data $f_s \geqslant 5$ bouts, the correlation coefficients are much higher: $r = -0.996$ (males) and $r = -0.990$ (females). The least-squares regression lines shown in Fig. 1 were calculated from these data. The slight difference in slopes opens a new question concerning possible differences in foraging between the sexes.

The model of scratching was tested by changing the probability of finding food. Because p in eq. (1) is a fraction, its logarithm is a negative number (hence the slope of Fig. 1 is negative). Reducing the probability of finding food should produce a flatter slope (more scratches/bout), and this prediction was tested by comparing scratching of males on the day seed was scattered ($N = 131$ bouts) and 4 days after ($N = 165$ bouts). The data were normalized to 100% for ease in comparison of the slopes, and are plotted in Fig. 2. As predicted, male towhees show more scratches/bout when food is less abundant. Based on $f_s \geqslant 5$ bouts, the correlation coefficients are $r = -0.998$ for both sets of data, and regression lines are fitted to these data. The slopes may be conveniently expressed as half-lives (equal to the medians), which are 1.4 scratches/bout on the day seed was scattered and 2.3 scratches/bout 4 days after providing seed. Data on females showed the same direction of difference, but are too few to merit formal analysis.

The model may have application to foraging behavior of other species, and is now sufficiently tested comparatively for emberizine scratching to be a useful tool in behavioral ecology. J.P.H. has begun experiments from which preliminary data indicate that a heavier leaf-litter also shifts the distributions to greater scratches/bout, suggesting that p is dependent both upon the abundance of food and the amount of litter in which it is concealed. These easily recorded data, especially if combined with measures of scratching per unit time, could therefore serve as a powerful quantitative measure of foraging efficiency for comparing individuals, sexes, habitats, seasons and so on.—

EDWARD H. BURTT, JR., *Dept. of Psychology, Univ. of Tennessee, Knoxville, TN* (Present address: *Dept. of Zoology, Ohio Wesleyan Univ., Delaware, OH 43015) and* JACK P. HAILMAN, *Dept. of Zoology, Univ. of Wisconsin, Madison, WI 53706.* *Accepted 29 Dec. 1977.*

Wilson Bull., 91(1), 1979, pp. 126–131

Winter diet of a bark-foraging guild of birds.—Although the literature of economic ornithology is replete with qualitative descriptions of the food habits of various birds, quantitative assessment of avian diets is seldom presented (Hartley, Ibis 90:361–381, 1948). For modern ecological analysis, earlier data reported in the literature are often inadequate for any one of several reasons. Birds were usually collected over large geographic regions, and therefore, fine scale comparisons are impossible. Evaluations of stomach contents were usually only subjective estimates; therefore, quantitative comparisons among species may not be reliable. Diets were often reported for the entire year; thus, few seasonal comparisons can be made. Here we report a quantitative analysis of the diets of bark-foraging birds which coexist in central Illinois during winter. The species include Red-headed Woodpecker (*Melanerpes erythrocephalus*), Red-bellied Woodpecker (*Melanerpes carolinus*), Downy Woodpecker (*Picoides pubes-*