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Wilson Bull., 102(3), 1990, pp. 542–545

"Foot-quivering" as a foraging maneuver among migrating *Catharus* thrushes.—We have observed a foraging technique ("foot-quivering") among *Catharus* thrushes that, heretofore, had been described only as an aggressive display used during intraspecific encounters. Foot-stirring or paddling behavior has been observed among foraging waders, gulls, and shorebirds

and presumably functions to bring invertebrates to the surface of the substrate (e.g., Rand 1956, Meyerriecks 1959, Hoyt 1961, Simmons 1961, Goss-Custard 1969, Pienkowski 1983). Among North American thrushes, analogous behavior has never been reported during foraging, although the Wood Thrush (*Hylocichla mustelina*) and the *Catharus* thrushes are all ground-foraging birds whose feeding behavior has been studied during the breeding and wintering seasons (Willis 1966, Paszkowski 1984, Holmes and Robinson 1988). Dilger (1956a, b) observed "foot-quivering" during hostile, intraspecific encounters on the breeding grounds, and Willis (1966) regarded "foot-quivering" as hostile behavior among wintering and transient thrushes in South America. We describe the behavior and suggest that "foot-quivering" as a foraging maneuver functions to flush prey.

The narrow woodlands (cheniers) along the Louisiana coast and the wooded barrier islands along the Florida, Alabama, and Mississippi Gulf coasts are important stopover sites for Nearctic-Neotropical passerine migrants following spring trans-Gulf migration (Moore and Kerlinger 1987). The Peveto Woods study site (29°45′N, 93°37′W) is a 3-ha coastal woodland located in Cameron Parish, Louisiana. The woodland supports a vegetation cover that includes tooth-ache tree (*Zanthoxylum clava*) and live oak (*Quercus virginiana*) but is dominated by hackberry (*Celtus laevigata*). Foraging observations were made in an area where the understory had been removed and the grass was mowed (approximately 10 cm high).

Observations of ground-foraging thrushes were made throughout the daylight hours between 06:30 and 18:00 CST in April 1988. Behavior of foraging individuals was continuously recorded during observation periods that averaged 104 sec for Gray-cheeked (*C. minimus*) and Swainson's (*C. ustulatus*) thrushes and 75 sec for Veerys (*C. fuscescens*). The frequency of occurrence and duration of "foot-quivering" were recorded for each individual during that time period. We also quantified the rate and pattern (orientation) of foraging movements by: (1) estimating the distance (m) moved while hopping or walking on the ground, (2) recording the number of pauses and feeding attempts, and (3) estimating the direction of movement with reference to the previous movement.

The distinctive feature of "foot-quivering" was a rapid movement of the legs and feet against the substrate without forward locomotion. The bird's neck and head were stretched forward while the bill was held parallel to the ground. After a bout of "foot-quivering," the bird scanned the substrate, presumably searching for prey that might move. "Foot-quivering" was often followed by quick pecking motions directed forward and at the ground. We sometimes observed prey flushed and captured by a foraging thrush at this time. After a bout of "foot-quivering," a thrush continued to hop or walk forward relative to its previous movement, which moved the bird over unsearched ground and decreased the likelihood of path recrossing (see Smith 1974).

Wood Thrushes were never observed to "foot-quiver" while foraging during stopover ($N = 103$), whereas all three *Catharus* thrushes were equally likely to employ this maneuver ($\chi^2 = 0.87$, $P > 0.05$) while ground foraging (Table 1). When the maneuver was observed, it occurred 4 times/min regardless of species. Although the average rate of "foot-quivering" movement varied among the three species (Table 1), the differences are not statistically significant (one-way ANOVA, $F = 0.88$, $P > 0.05$). "Foot-quivering" was followed by pecking movements (prey attacks) 60% of the time among Veerys, 67% in Gray-cheeked Thrushes, and 70% of the time among Swainson's Thrushes. Pecking rates were essentially the same among species and were comparable to those recorded when individuals were not observed "foot-quivering" (Table 1).

Although we do not question previous interpretations that regard "foot-quivering" as a hostile (intraspecific) display, the context in which "foot-quivering" occurred during our study and the frequent attempts to capture prey that followed the movements indicate that the behavior functioned to flush prey. Further, aggressive encounters were not observed

TABLE 1

QUANTITATIVE DESCRIPTION OF "FOOT-QUIVERING" AS A FORAGING MANEUVER AMONG *CATHARUS* THRUSHES DURING MIGRATORY STOPOVER

Species	% Foraging observations (N)[a]	Quiver rate[b]	Maneuver rate[c]	Pecking rate[d]	
				With	Without
Gray-cheeked Thrush	43 (90)	64 ± 14	4 ± 2	5 ± 2	5 ± 5
Swainson's Thrush	38 (56)	54 ± 15	4 ± 2	5 ± 3	4 ± 3
Veery	35 (48)	69 ± 13	5 ± 2	5 ± 2	4 ± 2

[a] Percentage of total number of foraging observations when maneuver observed.
[b] Mean ± one SD rate of foot-movements per min.
[c] Mean ± one SD frequency of maneuver per min.
[d] Mean ± one SD pecking rate per min with and without "foot-quivering."

among foraging thrushes employing this behavior, the behavior was always observed in a foraging context, and we never observed a response to "foot-quivering" by neighboring thrushes, although we cannot rule out a latent effect (i.e., "foot-quivering" may subtly maintain individual distance) and solitary thrushes showed the behavior.

Why "foot-quivering" as a foraging maneuver has not been observed outside of migration may be a function of sample size. The high number of individuals that concentrate at stopover sites following trans-Gulf migration and actively forage to replenish depleted energy reserves increases the likelihood the maneuver would be observed. Further, because acquiring enough food to meet energy requirements is an important constraint during migration, the appearance of "foot-quivering" during migration may represent an expansion of an individual's feeding repertoire. Alternatively, the expansion of habitat-use characteristic of the migration period may precipitate a corresponding change in the use of habitat-specific behavior.

Acknowledgments.—We thank C. Paszkowski and J. Walters for helpful comments on the original manuscript, the Baton Rouge Audubon Society for permission to study neotropical migrants at the Holleyman Migratory Bird Sanctuary, and Greg and Ginger Morris for providing accommodations during the 1988 field season. Research with neotropical migrants has been supported by a Sigma Xi Grant-in-Aid of research (WY), the Univ. of Southern Mississippi Research Council, the National Geographic Society, and the State of Mississippi Heritage Program.

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Wilson Bull., 102(3), 1990, pp. 545–550

A nonparametric aid in identifying sex of cryptically dimorphic birds.—Discriminant function analyses (DFA) have been used to sex birds from external morphometric characters (e.g., Shugart 1977, Ryder 1978, Rising and Shields 1980, Wooller and Dunlop 1981, Hanners and Patton 1985, Blohm 1987, Edwards and Kochert 1987). In some species, subtle nonmetric plumage characters may aid in sexing hand-held birds, but their inclusion in discriminant function models statistically is inappropriate. Here we present an alternative method (multiple logistic regression, MLR) for sexing birds based upon suites of morphometric and categorical plumage characteristics. We apply the method to a sample of White-throated Sparrows (*Zonotrichia albicollis*), a species difficult to sex based upon external characters outside the breeding season. MLR relates a dichotomous dependent variable (sex in this case) to several explanatory variables (i.e., morphological characters) (Harrell 1986). MLR has the advantage over other classification algorithms, such as discriminant function analysis (DFA), since its use is appropriate when assumptions of multivariate normality are violated (Press and Wilson 1978). Thus, it is possible to include categorical and dummy variables as explanatory variables. A step-wise procedure can be employed whereby a morphological variable is included in the regression model if its significance is less than a critical value (e.g., 0.05) and is removed if its significance falls above a critical value (e.g., 0.10) in order to identify those morphological characters most important in differentiating the sexes. The probability (P) of a specimen's belonging to a group (in this case the probability of a bird's being male, $Y = 1$) is then $P(Y = 1) = 1/(1 + \exp(-L_x))$ where L_x is the logistic function. The fraction of concordant pairs of observations (c) indicates the predictive ability of the model and is a better indicator than the percentage of correctly classified cases (Harrell 1986). This concordance is calculated by pairing all observations with different values of the dependent variable (Y) and then counting the number of cases where the individual with the larger Y has a higher estimated P than the individual with the smaller Y. Ties are counted