J. Field Ornithol., 70(4):578–586

DRUMMING AND TAPPING BY RED-BELLIED WOODPECKERS: DESCRIPTION AND POSSIBLE CAUSATION

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Abstract.—Although drumming (striking the substrate with the bill rapidly and repetitively) and tapping (striking the substrate regularly and at slower rates) are thought to play important roles in woodpecker communication, questions remain concerning the specific function(s) of these signals. To gain insight into the possible functions of drumming and tapping by male and female Red-bellied Woodpeckers (*Melanerpes carolinus*), we examined the use of these signals among different contexts and breeding stages. Only males were observed drumming, and rates were highest prior to pairing. Such timing suggests that drumming may be used to attract potential mates. Males also drummed during territorial intrusions by and boundary disputes with conspecific males, suggesting an aggressive or territorial function. Overall, drumming rates were relatively low ($\bar{x}$ = 0.35/h), perhaps because a frequently used ($\bar{x}$ = 12.5/h) vocal signal (*kwirr* call) serves similar functions and may encode more potential information. Male and female Red-bellied woodpeckers tapped and mutual tapped at low rates ($\bar{x}$ = 0.36/h and 0.09/h, respectively). These signals were used only at nest cavities, and rates were highest during the pre-pairing and post-pairing/pre-nesting periods. Such use suggests that tapping and mutual tapping play a role in establishing and maintaining pair bonds and in nest site selection.

DESCRIPCIÓN Y POSIBLE CAUSA DEL TAMBORILEO Y PICOTEO LENTO EN *MELANERPES CAROLINUS*

Sinopsis.—Aunque el tamborileo (golpear rápido y repetídamente un sustrato con el pico) y el picoteo ligero (golpear el sustrato regularmente pero a baja velocidad) son importantes en la comunicación de los pájaros carpinteros. Sin embargo, todavía queda por determinar la función específica de éstos. Para tratar de determinar la función de ambos tipos de picoteo, se estudió este tipo de conducta en individuos de ambos sexos de *Melanerpes carolinus* bajo diferentes contextos y durante diferentes etapas de la época de reproducción. Se observaron únicamente machos utilizar el tamborileo; la tasa fue mayor previo al apariamiento. Se sugiere que el tamborileo sea utilizado para atraer parejas prospectivas. Los machos también utilizaron el tamborileo cuando invadieron sus territorios y cuando hubo disputas en los bordes de éstos, sugiriendo dicha conducta una función de agresividad por disputa territorial. Las tasas de tamborileo resultaron ser relativamente bajas ($\bar{x}$ = 0.35/h), posiblemente porque las señales vocales (llamadas kwirr; $\bar{x}$ = 12.5/h) sirvan también para llevar a cabo este tipo de función, ademas de proveer de otra información. Ambos sexos utilizaron el picoteo ligero, tanto de forma individual como en un contexto mutuo, aunque con poca frecuencia ($\bar{x}$ = 0.36/h y 0.09/h, respectivamente). Este tipo de picoteo fue utilizado en los árboles con cavidades para anidar y su tasa de uso fue mayor durante el pre-apariamiento y el post-apariamiento. Este uso sugiere que el picoteo ligero, particularmente cuando es utilizado por dos individuos que se encuentran juntos, puede ser utilizado para establecer y/o mantener la unión entre parejas o en la selección de lugar para anidar.

Woodpeckers produce sounds by striking substrates with their bills. Some of these sounds are incidental to foraging, but others play an important role in intraspecific communication. These signals are generally

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referred to as drumming and tapping. When drumming, woodpeckers strike the substrate rapidly and repetitively. When tapping, woodpeckers strike the substrate regularly and at slower rates (Short 1982, Kilham 1983).

Previous investigators have suggested that woodpecker drumming serves the same functions as passerine song, including mate attraction and territory defense (Lawrence 1966, Winkler and Short 1978, Short 1982, Kilham 1983). Such conclusions, however, are largely based on observation, with little or no quantitative support. Similarly, based on observations of several species of woodpeckers, Kilham (1983) suggested that tapping may play a role in nest site selection and maintaining pair bonds. In addition, little is known about possible differences in the use of these signals by males and females. Further, only a few investigators have provided quantitative descriptions of these woodpecker signals (Winkler and Short 1978, Stark et al. 1998). Clearly, much remains to be learned about the structure of these signals and their possible functions.

Among the species of woodpeckers that regularly drum and tap is the Red-bellied Woodpecker (*Melanerpes carolinus*). Kilham (1983) suggested that melanerpine woodpeckers, specifically Red-bellied and Red-headed (*M. erythrocephalus*) woodpeckers, drum less frequently than species in other woodpecker genera, and that drumming by Red-bellied Woodpeckers is most common during conflicts. Tapping by Red-bellied Woodpeckers, as in other species of woodpeckers, may be associated with nest-site selection and pair-bond maintenance (Kilham 1983). The objective of our study was, in part, to examine the possible functions of drumming and tapping by Red-bellied Woodpeckers by noting the breeding stages and contexts in which these signals were used. In addition, we examined the characteristics of drums and tapping bouts, and whether the characteristics of these signals varied among breeding stages and contexts.

METHODS

Our study was conducted at the Central Kentucky Wildlife Management Area located 17 km southeast of Richmond, Madison Co., Kentucky (37°40′N, 84°10′W). Six feeding stations were maintained from October 1994–May 1995. Red-bellied Woodpeckers visiting these stations were captured in mist nets. Some woodpeckers were also lured into nets with recordings of *kwirr* calls and drums. Captured woodpeckers were banded with a numbered aluminun band and a unique combination of colored leg bands. Colored tape was also attached to the rectrices of each bird (Ritchison 1984).

Observations of male and female Red-bellied Woodpeckers were made from February–October 1995. Observation periods began when a focal bird was located, and continued until that bird was lost from view. When unable to locate a focal individual, we remained in its territory for 1 h. Territory boundaries were determined by monitoring the movements of woodpeckers and noting the locations of interactions.

We attempted to record all tapping and drumming with a Marantz

(Model PMD 430) cassette recorder and a Sennheiser directional microphone (Model ME88). We also recorded spoken notes concerning the behavior and movements of focal birds and the location and behavior of conspecifics.

Intrasexual contexts were categorized as spontaneous (no other individuals of the same sex vocalizing or interacting with the focal bird), long-range (focal bird apparently responding to the calling or drumming of a neighboring conspecific), and short-range (focal bird calling or drumming while approaching a conspecific of the same sex that had intruded into the focal bird's territory or while both are near a territory boundary). Intersexual contexts were categorized as either long-range (focal bird more than 10 m from its mate or other conspecific of the other sex) or short-range (focal bird less than 10 m from its mate or other conspecific of the other sex).

We also noted the breeding stage of each focal female, with the breeding period divided into the following stages: pre-pairing, post-pairing/pre-nesting, nest-building (excavation), incubation/nestling, and post-fledging/post-nesting. In some cases, breeding stage was determined by back-dating from the day of hatching (i.e., when adults began feeding nestlings) or the day of fledging. The incubation period was assumed to be 13 d and the nestling period 26 d (Kilham 1961, Stickel 1965, Jackson 1976).

Recordings of drums and taps were analyzed with a Kay Elemetrics DSP Sonagraph (Model 5500). Features of drums noted included duration, the number of beats per drum (with a beat defined as a single strike of the bill against a substrate; Stark et al. 1998), interbeat intervals (the time interval between individual beats during a drum), and the frequency at maximum amplitude (FMA). Beat rate was calculated as the number of beats per second during a drum.

A series of beats separated by intervals of no more than 1 s was referred to as a tapping bout. Such bouts were categorized as either tapping (with no conspecifics nearby) or mutual tapping (a male and female both tapping in the same tree). For tapping bouts, the duration and number of beats per bout were determined. For bouts of mutual tapping, the duration of the entire bout and the duration of each individual's (male and female) tapping bout were noted. The total number of beats and interbeat intervals were also noted.

Because not all individuals drummed and tapped and, for those that did, different numbers of drums and taps were recorded for each individual, sample sizes vary among statistical tests and descriptive statistics were based on subsamples (the same number from each individual) from different individuals. Subsampling eliminated the bias that occurs when pooling different numbers of samples from different individuals (Leger and Didrichsons 1994). Possible differences in drumming and tapping rates and in the characteristics of drums and tapping bouts among breeding stages and contexts were examined using repeated measures analysis of variance. Likelihood ratio tests were used to examine possible variation

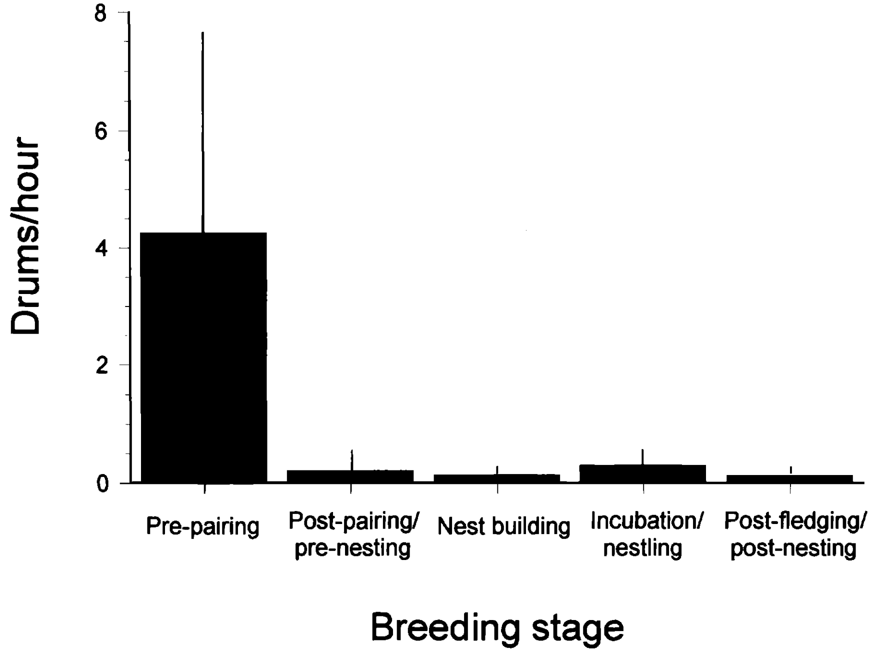

FIGURE 1. Drumming rates (x̄ ± SE) of male Red-bellied Woodpeckers during the breeding season, Madison County, Kentucky.

in the number of drumming and tapping bouts produced during different inter- and intrasexual contexts. All analyses were performed using the Statistical Analysis System (SAS Institute 1989). All values are presented as mean ± one standard error.

RESULTS

Male (n = 8) and female (n = 7) Red-bellied Woodpeckers were observed on 103 days for a total of 324 h from 23 Feb.–29 Oct. 1995, and, during this time, produced a total of 101 drums, 62 bouts of tapping, and 16 bouts of mutual tapping. Only males (n = 5) were observed drumming, and these males produced drums at a rate of 0.35 ± 0.13 drums/h. Drumming rates of male Red-bellied Woodpeckers varied among breeding stages ($F_{4,16} = 23.53$, $P < 0.0001$), with drumming rates highest during the pre-pairing period (Fig. 1).

Drums consisted of an average of 12.92 ± 0.40 beats (n = 76 drums of 4 males) and averaged 0.80 ± 0.03 s in duration (n = 76 drums). The mean beat rate was 16.31 ± 0.34 beats/s (n = 76 drums), and the mean FMA was 978.1 ± 49.5 Hz (n = 72 drums). Interbeat intervals ranged from 0.03–0.06 s, and decreased in duration as drums progressed.

Red-bellied Woodpeckers (n = 4 males and 4 females) engaged in an average of 0.36 ± 0.18 bouts of tapping/h, and tapping bout rates of

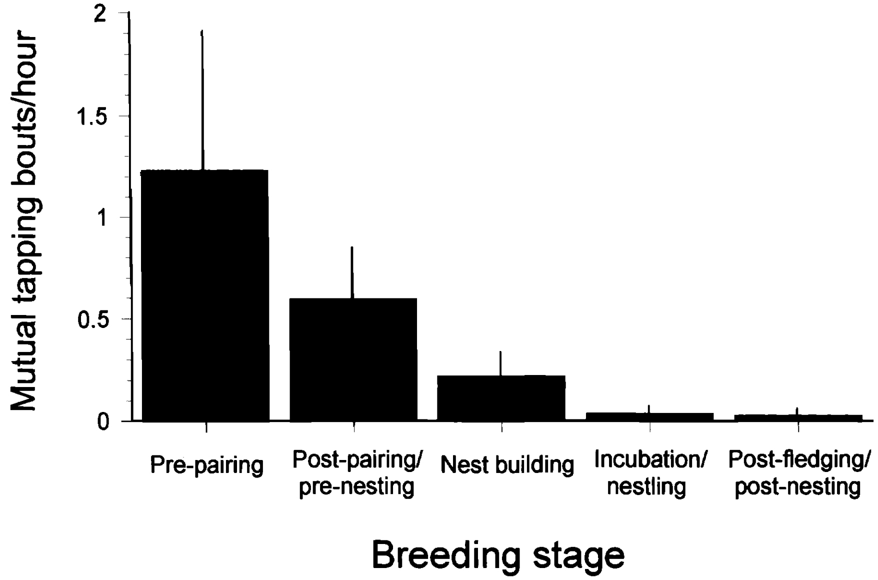

FIGURE 2. Mutual tapping rates (x̄ ± SE) of male and female Red-bellied Woodpeckers during the breeding season, Madison County, Kentucky.

males and females did not differ ($F_{1,4}$ = 0.81, P = 0.42). In addition, tapping bout rates did not vary among breeding stages ($F_{4,4}$ = 3.61, P = 0.12). The mean duration of these bouts was 1.75 ± 0.21 s (n = 12 bouts; two from each of six woodpeckers), and the mean number of beats per bout was 10.24 ± 1.14 (n = 12 bouts).

Paired Red-bellied Woodpeckers (n = 3 pairs) engaged in 0.09 ± 0.03 bouts of mutual tapping/h. Mutual tapping rates varied among breeding stages ($F_{4,4}$ = 20.6, P = 0.006), with more bouts per hour during the pre-pairing and post-pairing/pre-nesting periods (Fig. 2).

The number of bouts of drumming and tapping did not vary with intersexual context (χ^2 = 0.86, df = 1, P = 0.35), with similar numbers of bouts in short-range and long-range contexts. Similarly, the use of these two signals did not vary among intrasexual contexts (spontaneous, long-range, and short-range; χ^2 = 5.62, df = 2, P = 0.06).

Three males drummed during both long-range and short-range intersexual contexts. Drums produced in these contexts did not differ in number of beats/drum ($F_{1,2}$ = 2.08, P = 0.27), duration ($F_{1,2}$ = 1.42, P = 0.36), beat rate ($F_{1,2}$ = 0.09, P = 0.79), or FMA ($F_{1,2}$ = 0.19, P = 0.71).

Four male Red-bellied Woodpeckers drummed during spontaneous, long-range, and short-range intrasexual contexts. Drums produced during these contexts did not vary in number of hits/drum ($F_{2,2}$ = 13.22, P = 0.07), beat rate ($F_{2,2}$ = 18.32, P = 0.052), or FMA ($F_{2,2}$ = 1.5, P = 0.4). Drums did vary among these contexts in duration ($F_{2,2}$ = 42.05, P =

0.023). Spontaneous drums were shorter in duration ($\bar{x} = 0.78 \pm 0.17$ s) than those produced in either long-range ($\bar{x} = 0.83 \pm 0.31$ s) or short-range ($\bar{x} = 0.91 \pm 0.15$ s) contexts. The characteristics of drums did not vary among breeding stages (Repeated measures ANOVAs, $P > 0.2$).

The characteristics of tapping bouts ($n = 8$ woodpeckers) did not vary significantly with intersexual context (Repeated measures ANOVAs, $P > 0.4$). Similarly, the characteristics (duration, number of beats, and beat rate) of tapping bouts did not vary among breeding stages (Repeated measures ANOVAs, $P > 0.5$).

DISCUSSION

Overall, male Red-bellied Woodpeckers in our study drummed at relatively low rates ($\bar{x} = 0.35$ drums/h), and females not at all. Similarly, Kilham (1983) indicated that melanerpine woodpeckers, including Red-bellied Woodpeckers, drummed less frequently than other woodpeckers. Although few investigators have reported drumming rates, some species of woodpeckers are known to drum at higher rates than Red-bellied Woodpeckers. For example, Downy Woodpeckers (*Picoides pubescens*) in our study area averaged 5.6 drums/h, and females drummed at the same rate as males (Mahan 1996). Other species, however, may drum at rates comparable to those of Red-bellied Woodpeckers. For example, many larger woodpeckers use vocal signals in combination with drumming (Winkler and Short 1978) and, as a result, may drum at lower rates than smaller woodpeckers. Red-bellied Woodpeckers utter one vocal signal, the *kwirr* call, at higher rates than drums ($\bar{x} = 12.5$/h; Wilkins 1996), and these calls appear to serve the same functions as drums (Wilkins 1996). Large woodpeckers may use vocal signals in lieu of drums because such signals may encode more information than drums (Duncan 1990). In addition, large size makes possible the production of high amplitude, broad frequency calls effective over large distances (Morton 1986, Duncan 1990). The drums of smaller woodpeckers may be of greater amplitude than their vocal signals and, as a result, drums may be more effective, and used more often, when long-distance communication is necessary (Duncan 1990).

Although overall drumming rates were low, male Red-bellied Woodpeckers in our study drummed at significantly higher rates prior to pairing. Such results suggest that drumming by males plays a role in mate attraction. Observations of other species of woodpeckers also indicate that drumming may be used to attract mates (Bent 1939, Short 1982, Kilham 1983). For example, Lawrence (1966) reported that a male Downy Woodpecker "began drumming often and loudly after his mate was killed." Similarly, singing rates of males in several species of songbirds decline significantly after pairing, suggesting a role in mate attraction (Lampe and Espmark 1987, Bjorklund et al. 1989, Ritchison 1995). Thus, at least with regard to its role in mate attraction, drumming by male Red-bellied Woodpeckers, and males in some other species of woodpeckers, does appear to be functionally equivalent to passerine song.

Although drumming rates declined after pairing, male Red-bellied Woodpeckers in our study continued to drum throughout the breeding season. Such results suggest that drumming has functions other than mate attraction. One such function may be to indicate a willingness to interact aggressively with conspecific males. On several occasions, we observed male Red-bellied Woodpeckers drumming when conspecific males entered their territory or called near a territorial boundary (short-range intrasexual context). In addition, males in our study often responded to the playback of drums (and *kwirr* calls) in their territory by drumming (pers. obs.). Similarly, Kilham (1983) noted that drumming by Red-bellied Woodpeckers was "heard most commonly in conflicts."

Although we did not observe drumming by females, Kilham (1983) noted that both sexes of Red-bellied Woodpeckers "participate in vocalizations, drummings, and displays . . ." However, Kilham (1983) also noted that males drummed more than females, and that neither of two females kept in an aviary throughout a breeding season was ever observed drumming. These observations suggest that, while female Red-bellied Woodpeckers may drum, they apparently do so at very low rates.

The characteristics of drums produced by male Red-bellied Woodpeckers in our study were similar to those reported for other populations (Kilham 1961, Short 1982), suggesting that the characteristics of drums may vary little among populations. Drums of other species of woodpeckers, in contrast, appear to exhibit regional variation. For example, Stark et al. (1998) found that the characteristics of Northern Flicker (*Colaptes auratus*) drums varied with habitat, with those in coniferous forests drumming faster than those in oak woodlands. The reasons for such differences, or the absence of differences, remain unknown.

Although characteristics of the drums of male Red-bellied Woodpeckers did not vary either among breeding stages or between intersexual contexts, drums produced during intrasexual encounters were longer in duration than those produced spontaneously. Such results suggest that male Red-bellied Woodpeckers may vary drum duration to convey information concerning the likelihood of interacting, with the longer drums produced during long-range and, particularly, during short-range encounters indicating a greater likelihood of interacting. Similarly, Becker (1982) noted that males in several species of songbirds increase song length in conflict situations.

Red-bellied Woodpeckers tapped and mutual tapped at low rates, but rates were higher during the pre-pairing and post-pairing/pre-nesting periods. Such timing suggests that tapping may play a role in the establishment of pair bonds and the selection of nest sites. Kilham (1983) noted that tapping by Red-bellied Woodpeckers was associated with nest site selection and pair-bond maintenance. Boone (1960) reported mutual tapping during the early stages of pair formation and suggested that such tapping served as a recognition signal. Tapping may be used to inform a mate about the location of a nest hole (Winkler and Short 1978, Kilham 1983) or to test the thickness of the walls of a nest cavity (Kilham 1983).

Lawrence (1966) suggested that tapping by woodpeckers occurs almost exclusively in connection with the excavation period at or near or inside the cavity. Tapping and mutual tapping by Red-bellied Woodpeckers was only observed at nest cavities. For example, during observations of a pair after high winds broke the top off the snag in which their nest cavity was located, we noticed much tapping around the damaged cavity. This observation suggests that the pair may have been tapping to test the stability of the snag.

In summary, male Red-bellied Woodpeckers may drum at low rates because a vocal signal (*kwirr* call) that appears to serve the same functions may encode more information. Males do, however, appear to use drums to attract mates and defend territories. Tapping and mutual tapping occurred only at nest cavities, and our observations suggest that these signals play a role in nest site selection and, perhaps, in establishing and maintaining pair bonds.

ACKNOWLEDGMENTS

We thank Eugene Morton for helpful comments, and the Kentucky Ornithological Society (Burt L. Monroe, Jr., Avian Research Fund) and Department of Biological Sciences at Eastern Kentucky University for financial support.

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Received 3 Nov. 1998; accepted 2 Mar. 1999.