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Red-bellied Woodpecker

Melanerpes carolinus FRENCH: *Pic á ventre roux*

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This familiar, eastern U.S. woodpecker is an active and vocal species, with a preference for humid forests dominated by pines or hardwoods, or a mixture of both. It seldom excavates wood for insects; instead, depending on season, it forages opportunistically for a wide range of fruit, mast, seeds and arboreal arthropods. It is also known to take small or young vertebrate prey as well. The Red-bellied Woodpecker has expanded its range northward and westward in the latter half of the twentieth century. Most populations are resident year-round, although northern birds show some seasonal movement by retreating south during cold winters. In the southeastern United States, it is the most abundant woodpecker; in the northern half of its range, it is much less common. This woodpecker does well in urban settings, but also occurs in more remote, wilderness sites. Its generalistic foraging and nesting habits have helped in its range expansion.

The Birds of North America
Life Histories for the 21st Century

Many aspects of the life history of this species have been well studied. The basis for what is known comes mainly from Bent 1939, Short 1982, and Kilham 1983. Excellent theses on general ecology (Boone 1963, Stickel 1963b, Breitwisch 1977) and foraging (Towles 1989) exist. More specific descriptions are available regarding habitat (Williams 1975, Conner 1980, Conner et al. 1994, Shackelford 1994, Shackelford and Conner 1996, 1997), breeding (Kilham

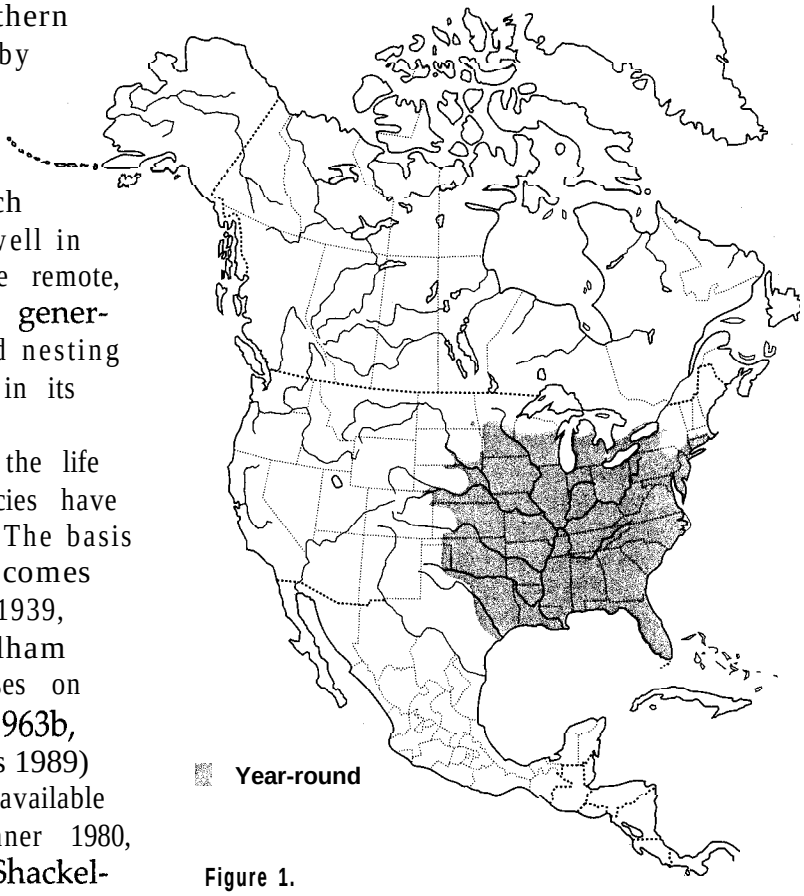

Figure 1.
Distribution of the Red-bellied Woodpecker.

1961, 1977, Stickel 1965a, Jackson 1976a, Ingold 1989a, 1989b, 1991), hybridization (Gerber 1986, Smith 1987), range expansion (Forsberg 1982, Haas 1987, Maddux 1989, Jowsey 1992, Dales and Dales 1992) and foraging (Willson 1970, Gamboa and Brown 1976, Askins 1983).

The Red-bellied Woodpecker's nutri tion, physiology, and short-range movements remain little studied. It does not appear to be a species of concern; much of its population is either stable or increasing.

DISTINGUISHING CHARACTERISTICS

A medium-sized woodpecker about 24 cm in length with a zebra-patterned back. Males have red forehead, crown, and nape, while females have red only on the nape. The actual "red belly" is limited to a small portion of the ventral region between the tarsi and is difficult to observe in the field. Adult plumage remains the same throughout the year. Immatures lack red on head and have a horn-colored bill.

Away from the far southwestern limits of its range, it is the only woodpecker with plain grayish underparts (including face) and black-and-white barred upperparts. Slight overlap in central Texas and a tiny portion of Oklahoma with the similar Golden-fronted Woodpecker *(Melanerpesaurifrons)*, but head pattern and color are very different. Golden-fronted has nasal tufts and entire nape golden orange (with red crown in males), while Red-bellied typically shows only bright reddish (not golden) coloration on head. Red-bellied also shows white-barred, not black, central rectrices. The legs and feet are dark gray, the bill black and the eyes are reddish brown. The two usually occur in very different habitat types. Voices are similar, but the Red-bellied's calls are softer, higher pitched, and less raspy when compared to those of the Golden-fronted.

While this woodpecker's range overlaps with the nominate Golden-fronted, it does not occur with any similarly plumaged woodpeckers in its former genus, *Centurus* (e.g., Gila *[M. uropygialis]*, in sw. U.S. and nw. Mexico; Red-vented *[M. pygmaeus]*, in the Yucatan Peninsula; and *M. aurifrons leei*, a Red-bellied lookalike on the Isle of Cozumel; Howell and Webb 1995).

DISTRIBUTION

THE AMERICAS

Widely distributed throughout eastern half of U.S., occurring west to wooded portions of Great Plains (mainly east of 100°W) and north to extreme s. Ontario (Fig. 1). Resident fromcentral Minnesota (north to Pine, Aitkin, Crow Wing cos.; Janssen 1987), n. Wisconsin (north to Burnett, Marathon, Marinette Cos.; Robbins 1991), n. Lower Peninsula of Michigan (McPeek and Pitcher 1991), extremes. Ontario (mainly south of 44°N in Carolinian Forest Zone; Woodliffe 1987), western half and southeastern corner of New York State (Meade 1988), and s. Massachusetts (Connecticut River Valley, Worcester Co., and se. Massachusetts; Veit and Petersen 1993), south throughout e. U.S. tos. Florida (including Florida Keys), and the Gulf Coast (Stephenson and Anderson 1994, Am. Ornithol. Union 1998). Resident west to se. North Dakota (lower Sheyenne River; P. Lehman pers. comm.), s. South Dakota (extreme southeastern counties and locally west along Missouri River and its tributaries; Peterson 1995), central and sw. Nebraska (breeds west along the Platte and other major rivers; Johnsgard 1979), extreme ne. Colorado (along South Platte and other rivers; Winternitz 1998), w. Kansas (Kansas Breeding Bird Atlas [BBA] 1992-1997 unpubl.), panhandle of w. Oklahoma, and e. Texas (eastern panhandle and eastern third of areas south of panhandle; Texas BBA 1987-1992 unpubl.). Records of breeding from Connecticut and Massachusetts suggest a dynamic breeding range in ne. U.S., likely a function of a warming climate (Robinson 1977, Sullivan 1992). Most common breeding woodpecker in forests of pine, hardwood or pine-hardwood mix in e. Texas (Shackelford and Conner 1997) and undoubtedly rest of se. U.S. where much of same habitat occurs. In ne. U.S., Red-bellies occur more numerously in pure deciduous forests than in pine-oak forests (e.g., Walsh et al. 1999).

Although generally resident throughout its range, some individuals evidently migratory (e.g., Sibley 1997), especially at northern edge of range (Short 1982). Many casual records from areas just outside of regular range (including areas north of regular range) have occurred during winter (Barrette 1996, Smith 1996).

Other records. Casual north to Idaho, s. Saskatchewan, n. Montana, se. Wyoming, s. Manitoba, central Ontario. s. Quebec, New Brunswick, and Nova Scotia, and west to se. Colorado and e. New Mexico (Am. Omithol. Union 1998).

OUTSIDE THE AMERICAS

Not recorded

HISTORICAL CHANGES

Expanding fairly rapidly to the north, probably owing to maturing forests in the Northeast and an increase in backyard feeders (Meade 1988, Jackson and Davis 1998). Range expansion northwest probably facilitated by following wooded river bottoms into the Great Plains where planted trees have

matured in urban lots. Edge or extralimital records in U.S. appear in: Connecticut (Ripley 1988), Massachusetts (Robinson 1977), Minnesota (Forsberg 1982, Link 1983), Nebraska (Maddux 1989), Pennsylvania (Haas 1987), and S. Dakota (Parrish 1980, Skadsen 1983). In Canada, records include: Manitoba (Cartwright 1942, Hatch and L' Arrivee 1981) and Saskatchewan (Nero 1959, Brazier 1970, Dales and Dales *1992,* Jowsey 1992).

Has been expanding its range for some time. Early records for northern limits include: Maryland (Fisher 1903), Massachusetts (Brewster 1881), Minnesota (Roberts 1932), and Wisconsin (Schoenebeck 1939, Schorger 1947, Peterson 1951). A recent review of the range expansion is detailed in Jackson and Davis 1998.

FOSSIL HISTORY

Pleistocene records from Virginia and Florida and more recent, but still prehistoric, records from Georgia (Brodkorb 1971).

SYSTEMATICS

GEOGRAPHIC VARIATION

Pattern of barring on upperparts and coloration of body and belly patch subject to high degree of individual variation and not necessarily correlated on geographic basis (K. Parkes in Bull 1964). Study of geographic variation by Burleigh and Lowery (1944) suggested that populations east of the Mississippi River valley average darker on upperparts (whitebars narrower thanblackbars) with a deeper red belly patch than populations to the west, where individuals also thought to be paler gray with a lighter shade of red on belly. These differences were not found by Mengel (1965; also see Bull 1964). Burleigh and Lowery (1944) also reported that Florida individuals tend to be whiter above (broader white bars) with a paler forehead than birds to the north. Again, this tendency not found by Stevenson and Anderson (1994). Birds in the southwesternmost part of species' range (i.e., central and e. Texas) said to be grayer on the throat and cheeks than other populations (Koelz 1954).

SUBSPECIES

Currently regarded as monotypic (Short 1982), although 4 subspecies listed by Am. Omithol. Union 1957, which then noted that definite boundaries between some taxa were uncertain. Recognition of subspecies largely based onconclusions of Burleigh and Lowery (1944) and Koelz (1954). Limited studies since have not found consistent differences and suggest that some subspecies should not be recognized (Mengel 1965, Stevenson and Anderson 1994). Critical evaluation of populations in the Florida Keys and Texas still needed (see, e.g., Pyle 1997). Formerly recognized subspecies and ranges ascribed to them: *Melanerpes c. carolinus* (Linnaeus, 1758), southern and eastern part of range east of Appalachian Mtns.; *M. c. zebra* (Boddaert, 1783), westandnorthof "nominate *carolinus*"; *M.* c. *pet-plexus* (Burleigh and Lowery, 1944), s. Florida from Venice, Fort Myers, and Stuart south through Florida Keys; *M.* c. *harpaceus* (Koelz, 1954), central and e. Texas.

RELATED SPECIES

Red-bellied and parapatric Golden-fronted woodpeckers, along with allopatric Gila, Hoffmann's, and West Indian *(M. superciliaris)* woodpeckers, thought to constitute a superspecies, according to Short (1982). These and 5 other species of barred-backed woodpeckers often separated from *Melanerpes* in genus *Centurus* (Am. Omithol. Union 1998).

Reportedly hybridizes with Golden-fronted Woodpecker in limited area of recent contact in SW. Oklahoma (Smith 1987). Although Selander and Giller (1959) found no evidence of hybridization, recent contact has produced birds withintermediate morphology and mixed genic composition (Smith 1987; see Appearance: aberrant plumages, below). Habitat selection apparently differs between the 2 species in zone of overlap, with Golden-fronted preferring semiarid brush country with honey mesquite *(Prosopisglandulosa)* being the dominant cover, while the Red-bellied is a species of more moist/mesic eastern forests (Oberholser 1974).

MIGRATION

Generally not considered a migratory species, but anecdotal information suggest that northern populations retreat south during harsh winters at unknown rates (Winkler et al. 1995). Great Lakes populations (e.g., Michigan), e.g., often experience cold that drives them south (McPeek and Pitcher 1991). Some authors have suggested that the increase in residential bird feeding has been a major factor in the northward expansion of this species (Meade 1988, McPeek and Pitcher 1991). Movements of undetermined distances between different forest types apparently occur in the South; e.g., more individuals are found in bottomland hardwood forests in winter, when mast production is high (Shackelford and Conner 1997). Small numbers migrate past Cape I. at Cape May, NJ, mainly mid-Sep-late Oct (rarely as early as 7 Aug), and apparent migrants also seen occasionally in May (Sibley 1997). Probable migratory movements are noted in Pennsylvania along southern shore of Lake Erie fourth week Apr through second week May (Mc-

Williams and Brauning 2000). Possible migrants also struck towers in Leon Co., FL, 24 Oct 1979 and 19 Dec 1959 (Crawford 1981).

HABITAT

BREEDING RANGE

Broadly adaptable. Primarily associated with dry to wet sites consisting of relatively mature hardwoods where large-diameter trees are present, but readily uses mixed pine-hardwood forests in the Deep South, where it nests in pine snags; also occurs commonly in mesic pine flatwoods (Bent 1939). Inhabits heavily timbered bottomlands, swampy woods, and riparian forests heavily wooded with oaks and elms (Selander and Giller 1959).

Common in oak (Quercus)-hickory (*Carya*) forests of Illinois, also in bottomlands, flood plains, and areas where maples (*Acer*) and hackberry (*Celtis*) are dominant trees (Reller 1972). In Virginia, primarily in oak-hickory hardwood forests with denser mid-story and understory conditions than habitats used by other woodpecker species; also found in pitch pine (*Pinus rigida*)-oak and tuliptree *(Liriodendron tulipifera)*-oak forests, and in suburban sites where mature trees and snags are present (Conner 1980). Nests in open habitats in Texas where utility poles and fence posts are the only available nest and roost sites (Bent 1939). Mixed pine-hardwood forests used rarely in central Appalachians. In e. Texas, regularly found in undisturbed bottomland hardwood forests, mixed pine-hardwood forests, and longleaf pine (*Pinus palustris*) Savannah habitat during the breeding season (Shackelford and Conner 1997).

In general, foraging and nesting habitats of Red-bellied Woodpeckers tend to have greater tree density and midstory and understory density than those of other woodpecker species in thee. U.S., as well as requiring large snags (dead trees). Usually occurs below 600 m elevation, but can be found up to 900 m in the Appalachians (Short 1982). See also Breeding: nest site, below.

WINTER RANGE

Similar to breeding-range habitats, although shifts to more southerly forest habitats where temperatures are milder and the species can concentrate in bottomland hardwood forest where mast is abundant.

FOOD HABITS

FEEDING

Arthropods, mast (= acorns and nuts), fruits, seeds, sap. Generalistic and opportunistic feeder.

Microhabitat for foraging. Mainly trunk. limbs. and branches of standing trees and snags, but may vary with habitat, food availability, season, and sex of the individual. Species apparently concentrates on different foraging sites on trees in different areas, though comparisons among studies are difficult because of different microsite definitions and divisions. Much of variation in use of specific foraging substrates may be related to food availability. In Maryland, foraged 70% of time on branches, 26% on trunks, and 4% on stubs (n = 3,811 observations at 10 s intervals; Moulton and Adams 1991); in e. Texas, branches used 75%, trunks 20%, and twigs 5% of time (n = 111 observations; Conner et al. 1994). In autumn in Illinois, 45% of time was spent foraging on limbs, 35% on branches, and 20% on trunks; winter percentages were similar (*n* = 15,740 s of observation total; Reller 1972). In s. Florida, microhabitat for foraging varied greatly with habitat type and availability of seasonally and locally abundant foods; in pine-hardwood and pine-palmetto habitats, 68.2% of time was spent foraging on trunks, with lesser time spent on other tree surfaces, but pine cones, fruits, and other seasonal food supplies were used to a high degree when available (*n* = 18,825 s of observation total); in suburban subtropical habitat with fruiting trees available throughout the year, only 31.3% of time was spent foraging on trunks and 33.6% of time on fruits (n = 33,479 s of observation total; Breitwisch 1977).

Foraging habitat may differ between sexes; in several studies, males foraged more on trunks than females did, and females more on limbs than males (Willson 1970, Reller 1972, Towles 1989). Birds in central Kentucky foraged at an average height of 11.7 m on trees with an average height of 21.9 m (Towles 1989). Other reported mean foraging heights were 6.9 m ± 0.9 SE in Iowa (Gamboa and Brown 1976) and 17 m in Maryland and Minnesota (Askins 1983). In e. Texas, foraged higher on snags (approx. 18 m) than on live trees (approx. 11 m) or dead branches in live trees (approx. 11.5 m; Conner et al. 1994). Females tend to forage higher on trees than males and forage in taller trees, but a high degree of overlap in foraging heights occurs between the sexes. In several areas, foraging height varies seasonally; dependent on differences in food availability and nesting behavior (Reller 1972, Askins 1983, Towles 1989).

Apparently forages on dead wood more often than expected in some areas, often using dead limbs in live trees (Williams 1975, Gamboa and Brown 1976, Brawn et al. 1982). In e. Texas, by contrast, individuals (n = 111) foraged on live substrate 54% of time, 30% on snags, and 8% on dead limbs on live trees (Conner et al. 1994); Towles (1989) in Kentucky and Willson (1970) in Illinois observed Red-bellied

Woodpeckers foraging 76.2% (n = 650 observations) and 84% (n = 241 observations) of time, respectively, on live wood versus dead wood. In s. Florida, Breitwisch (1977) found a seasonal shift in live- and dead-wood foraging use: breeding season, 84.8% live wood, 15.2% dead wood (n = 18,314 s of observation total); nonbreeding season, 65.8% live wood, 34.2% dead wood (n = 18,534 s of observation total).

Selection of tree species for foraging often depends on food availability and may vary with habitat type, season, and sex of bird. In Illinois, Red-bellied Woodpeckers were the most selective of tree species of 5 bark-foraging species (Willson 1970). Trees were used in the following frequencies in an e. Texas bottomland: 36.4% oaks, 18.2% blackgum *(Nyssu sylvatica),* 9.1% sweetgum (*Liquidambar styraciflua),* 9.1% pines (*Pinus* spp.) and snags 27.3% (Conner et al. 1994). Reller (1972) in Illinois also found that oaks were consistently favored, but Williams (1975), also in Illinois, observed birds using sugar maples (*Acer succhurum)* more often than expected based on availability. In diverse mixed mesophytic forests of central Kentucky, Red-bellied Woodpeckers foraged on 26 tree species, but used shagbark hickory (*Carya ovata*), sweetgum, and Shumard oak *(Quercus shumardii)* significantly more than expected (Towles 1989).

Towles (1989) and Askins (1983) reported a higher use of nut-bearing trees (*Fagus, Quercus, Carya*) in fall and winter when mast was mature, and Breitwisch (1977) reported a continual change in foraging tree selection as different plants produced fruit. Use of tree species in Illinois differed with season and sex of bird, with males concentrating on oaks (*Quercus* spp.) and white ash *(Fraxinus americana)* in winter and sugar maple and white ash in spring, and females using more oaks and sugar maple in both seasons with an increased use of dead wood in spring (Willson 1970). Birds in Maryland also showed sexual differences in tree-species use, with males using more sweetgum and tuliptree and females using more northern red oak *(Quercus rubru)* and red maple *(A. rubrum;* Askins 1983).

Food capture and consumption. Uses a variety of foraging methods: gleaning, probing, excavating, pecking, bark scaling, and hawking for arthropods; feeding on berries, fruits, seeds, nuts; occasionally drinks sap and nectar (bird feeders). Small prey are swallowed whole, and larger prey (e.g., nestling birds, lizards, small mammals, large caterpillars, large insects) are killed by thrashing against trees or pecking, and then are torn to pieces before swallowing (McGrath 1988, Smith and Jackson 1994, Trail 1991).

When foraging on small fruits, berries, or seeds, may perch upright or hang upside-down from fruit cluster or terminal branch, or may hover briefly while obtaining food (Breitwisch 1977, Kilham 1963, REB). Prefers to forage for fruits and nuts in trees, but will occasionally take fallen items (Beal 1911, Williams 1975, Towles 1989). When feeding on large fruits (e.g., oranges, grapefruit, mangos), may hang directly from fruit or perch on terminal branches; may return to same large fruit for several days, thus keeping agricultural losses low (Beal 1911, Breitwisch 1977). Feeds on seeds and nuts with tough seed coats (e.g., sunflower [*Helianthus annuus*] seeds, hickory nuts) by wedging into crevices in trees or posts, breaking seed coat or shell by hammering with bill, and hammering meat into small pieces (Mueller 1971, Towles 1989). May catch dropped food items when feeding on vertical surfaces by pressing belly and breast against tree with or without cupping action of wing to catch food (Kilham 1983, Reynolds and Lima 1994).

Askins (1983) reported the following foraging method frequencies in Maryland and Minnesota, respectively: short excavation (<30 s) 5.4, 12.4%; long excavation (>30 s) 0.6, 13.1%; probing excavation 1.4, 0.8%; probing surface 26.5, 62.4%; fruit and nut foraging 64.7, 11.1%; gleaning 1.3, 0.1%. In a mixture of rural and suburban habitats in Maryland all seasons, Aug-May, Red-bellied Woodpeckers used gleaning 78.9%, pecking 7.9%, excavating 3.1%, ground foraging 2.0%, scaling 1.9%, and suet use 6.2% of time (n = 3,811 observations, number of birds unknown; Moulton and Adams 1991). In e. Texas bottomlands, birds used 59% peer-and-poke, 34% pecking, 5% scaling, 1% excavating, and 1% hawking (Conner et al. 1994). In central Kentucky with data from all seasons combined, birds used 27.2% gleaning, 22.4% probing, 22.4% pounding, 17.9% gathering (fruits and nuts), and 10.1% pecking (n = 648 observations, 31 birds; Towles 1989). In Kansas from Apr-Jul (n = 21 Red-bellieds), 61.8% gleaning, 29.4% fruits and seeds, 2.9% pecking, 2.9% sap, and 2.9% stooping on terrestrial invertebrates (Jackson 1976a). In3 s. Florida habitats: 66.9% probing and gleaning, 27.0% fruit-taking, 5.6% pecking, 0.5% bark flaking, and 0.1% fly-catching (n = 52,304 s of observation total; Breitwisch 1977).

Foraging mode may differ with habitat type, probably as a function of food availability; e.g., Breitwisch (1977) in s. Florida found thatfruit-taking occurred more often in suburban areas than in rural habitats because of the abundance of fruiting ornamental trees and the lack of available snags in suburban habitat. Seasonal variation in foraging mode also occurs throughout this species' range, and is greatly dependent on the timing of fruits and mast maturation as well as prey availability (Askins 1983, Towles 1989). Several researchers have found sexual differences in foraging methods used (Selander 1966, Willson 1970, Towles 1989); e.g., Towles

(1989) found that males pecked, pounded, and gathered more than females, and females gleaned and probed more than males. However, Wallace (1974) and Askins (1983) found no significant differences in foraging mode and found a high degree of overlap in foraging method between sexes.

FOR FEEDING. Numerous anatomical adaptations for its specific modes of feeding. This generalist is intermediate in osteological adaptations (for pecking, chiseling, and drumming) between more arboreal (e.g., *Picoides*) and terrestrial (e.g., *Colaptes*) North American woodpeckers (Burt 1930).

Red-bellied's tongue is highly modified: cylindrical, pointed, and barbed at tip, aiding in extraction of prey from crevices; tongue extends about 2.5-4 cm beyond tip of bill and is more highly maneuverable, making this species more successful at extracting prey from crevices than other woodpeckers studied (Kilham 1963). Enlarged sublingual mucous gland serves to make the tongue sticky, and a special nasal mucous gland is thought to exclude wood chips and dust from nasal passages (Beecher 1953). Male has a significantly longer bill and a longer, wider tongue tip than female, which may have implications for resource partitioning, as males may be able to reach deeper into furrows to extract prey (Wallace 1974, Towles 1989).

TIME OF DAY FOR FEEDING. In Illinois, times of day of peak foraging activity (% of total daily foraging time occurring in each time interval) differed somewhat between autumn and winter, respectively: 27% and 13% from sunrise to midmorning, 15% and 30% from midmorning to noon, 33% and 30% from noon to mid-afternoon, and 25% and 27% from mid-afternoon to sunset (Reller 1972). Average foraging time in Illinois spent at each site between flights: males: winter 95 s, spring 101 s; females: winter 46 s, spring 72 s (n = 13,643 s of observation total; Willson 1970).

DIET

Majorfood items. Wide range of fruits, mast, and seeds and arboreal arthropods and other invertebrates. Takes small or young vertebrate prey opportunistically; e.g., green anole (*Anolis carolinensis;* Beal 1911, Smith and Jackson 1994); Brown anole (*Anolissagrei;* Breitwisch 1977); tree frogs (Beal 1911); small fish ("minnows") probably scavenged whole from lake shore (Nero 1959);nestling birds: American Redstart (*Setophaga ruticilla;* Watt 1980), Carolina Chickadee (*Poecile carolinensis;* Conner 1974), Hairy Woodpecker (*Picoides villosus;* Grimes 1947), Red-cockaded Woodpecker (*Picoides borealis;* Jackson 1977a), House Wren (*Troglodytes aedon;* Neil1 and Harper 1990), and others. Also takes bird eggs (Brackbill 1969, Rodgers 1990, Walters 1990).

Observed to feed on sap at holes in bark created by Yellow-bellied Sapsuckers (*Sphyrapicus varius)* in sugar maple, pin oak (*Quercus palustris*), slash pine (*Pinus elliotii*), and flamboyant tree (*Delonix regia;* McGuire 1932, Kilham 1963, Breitwisch 1977). Has been observed to drink nectar in s. Florida from banana (*Musa* sp.), silk-oak (*Grevillea robusta*) and exotic myrtle (*Melaleuca quinquenervia* and *Callistemon lanceolatus*) blossoms (Breitwisch 1977). Will take a variety of foods at feeding stations, including seeds, suet, fruits, peanut butter, meat, etc.

Quantitative analysis. Diet 69.06% vegetable and 30.94% animal matter by volume, based on contents of 271 stomachs obtained throughout the species' range and throughout the year (Beal 1911). The vegetable matter consisted of 5.8% corn (Zea *mays),* 39.5% fruit, and 44.5% mast (acorns, pecans, beechnuts, and hazelnuts), and 10.2% unidentified vegetable matter; animal matter consisted of 32.9% Coleoptera (including ground beetles, weevils, etc.), 25.5% Hymenoptera (20.8% ants, 4.7% others), 18.8% Orthoptera (including grasshoppers, mantids, cockroaches), 6.0% Hemiptera (mostly stink bugs, some scales), 9.3% Lepidoptera (caterpillars), and 7.5% miscellaneous (spiders, millipedes, tree frogs, green anole, snail).

Winter diet in central Illinois: 94.0% vegetable and 6.0% animal (based on relative frequency of items in 20 stomachs; Williams and Batzli 1979). Vegetable matter consisted of 70.9% corn, 8.8% hard mast (mostly *Quercus* sp.), 0.6% haw fruit (*Crataegus* sp.), 9.4 % grapes *(Vitis* sp.), 2.4% hackberries (*Celtis occidentalis),* 1.9% unknown fruit; animal matter 0.3% Orthoptera, 0.3% Homoptera, 4.0% Coleoptera, 0.8% Hymenoptera, and 0.6% unknown.

Using contents of 19 gizzards collected from Oct through Apr in Kansas, estimated diet 74.5% vegetable, 25.5% animal (Boone 1963); % gizzards containing fruits from the following genera of plants were 63% corn, 58% beggar's ticks *(Desmodium),* 26% wild grape *(Vitis),* 5% Virginia creeper (*Parthenocissus),* 5% false grape *(Ampelopsis),* 10% greenbrier (*Smilax*), 5% wild cherry *(Prunus), 5%* dogwood *(Cornus),* 5% poison ivy *(Toxicodendron),* and 21% unidentified. The following taxa of invertebrates were also found in these percentages of gizzards: Acarina: Acaridae 5%; Araneida: Linyphiidae 5%; Chilopoda: Geophilidae 5%; Coleoptera: Curculionidae 5%, Elateridae 10%, Nitidullidae 5%, unidentified 10%, larvae 5%; Hymenoptera: Formicidae 63%, Larridae 5%; Isoptera: Rhinotermitidae 5%; Lepidoptera larvae 5%; Mallophaga egg cases 10%; Orthoptera: Blattidae adults and egg cases 15%; Nematoda 5%; unidentified 21%.

In Kentucky, mostly in winter, observed to forage on foods in the following frequencies: 43.8% shagbark

hickory nuts, 29.2% corn, 6.0% acorns, 5.9% shellbark hickory (*Carya laciniosa*) nuts, 4.9% poison-ivy berries (*Toxicodendron radians*), 5.9% hackberries, 2.7% sunflower seeds, 1.1% bitternut hickory (*C. cordiformis*) nuts, and 0.5% persimmons (*Diospyros ebunuster*; Towles 1989).

Proportion of food items in diet may vary widely between seasons within a given area; depends greatly on availability. Martin et al. (1951), using data from Beal (1911), found that vegetable matter composed 82% of diet in winter, 44% in late spring, 60% in summer, and 83% in fall. Seasonal variations in proportions of individual food items in diet may also occur; e.g., Beal (1911) found that beetles made up 27% of total diet in May, but only 1% of total diet in Dec.

FOOD SELECTION AND STORAGE

From Kilham 1963. May store food throughout the year, but most prevalent in fall. Small items are stored whole, but larger objects are usually broken into pieces before storage. Usually uses storage sites that are readily available and require no excavation, such as pre-existing cracks or crevices in trees or posts or in vine rootlets on the trunks of trees. This species lodges food items deep (5-7 cm) in crevices to protect items from other animals. May store food items a few centimeters to >100 m from where collected. May store items from one food source in several locations and apparently does not defend food stores. Appears to have knowledge of where stores are hidden, probably reinforced by habit of occasionally locating and restoring items.

Reported to store nuts, acorns, corn, grapes, various seeds and berries, and insects; 1 Red-bellied Woodpecker in Kansas reported to store cow dung, and captive birds observed to cache miscellaneous objects: nails, toothpicks, wood slivers, paper clips and paper (Boone 1963, Kilham 1963, Oberholser 1974). Apparently does not store mast in s. Florida (Breitwisch 1977).

NUTRITION AND ENERGETICS

No information available.

METABOLISM AND TEMPERATURE REGULATION

Little information. See Breeding: incubation, below. In morning and during cool or rainy weather, both adults spend more time on eggs; in warm weather, adults pant when hot (Stickel 1965a, Jackson 1977a).

DRINKING AND DEFECATION

No information available (no abnormal behaviors reported).

SOUNDS

VOCALIZATIONS

An extremely vocal species year-round. However, drumming and calls are more prevalent in late winter and spring, when individuals are more territorial and nesting.

Development. Young birds in nest, like most woodpeckers, give a raspy, begging call when an adult appears at the entrance hole. About a week prior to fledging, young begin to give adult-like calls, but with a higher and noticeably different tone (CES). No evidence for vocal learning.

Vocal *array*. Six different calls used by this species (Wilkins 1996).

Kwirr. Most frequently heard call (Wilkins 1996), also translated as *ckurr* call by several authors (see Kilham 1961, Stickel 1963b, Short 1982; see Fig. 2A). Heard most often during breeding season, where it probably serves to elicit a response from a conspecific (Kilham 1983), but also may be used for mutual recognition between pairs or to attract a mate (Boone 1963). May also serve to call a mate to or from the nest cavity (Jackson 1976b).

Cku. Described as a long-range location call given most frequently during postpairing/prenesting period and during female prefertile periods (Wilkins 1996), but also given as an alarm call or when a bird is excited (Boone 1963, Kilham 1983).

Cku groups. Similar to the *cku* calls, likely a long-range intersexual contact call, given most frequently during postpairing/prenesting period and during female prefertile period, but also may be emitted to express mild excitement (Wilkins 1996).

Cku-au-ah. Likely serves an aggressive or territorial function, since most frequently given during short-range inter- and intrasexual contexts at a rate of 0.12 calls/h (Wilkins 1996).

Ckee-wuck. Given at a higher rate during prepairing period and usually when conspecifics are nearby (Wilkins 1996). Given most often when engaged in intraspecific conflicts at any time of the year (Boone 1963, Kilham 1983).

Grr. Also known as intimate call; usually given by mated birds that are near each other (Kilham 1961). Females give this call when approaching the nest (Boone 1963). This contact call maybe important in those that establish and maintain a pair bond; most often given early in the breeding season or prior to and during the female's fertile period (Wilkins 1996).

See also Breeding: young birds, fledgling stage, below.

Phenology. Most vocalizing is associated with the breeding cycle; mainly to announce and maintain a territory. Mated pairs vocalize year-round, but least often outside of the nesting season or

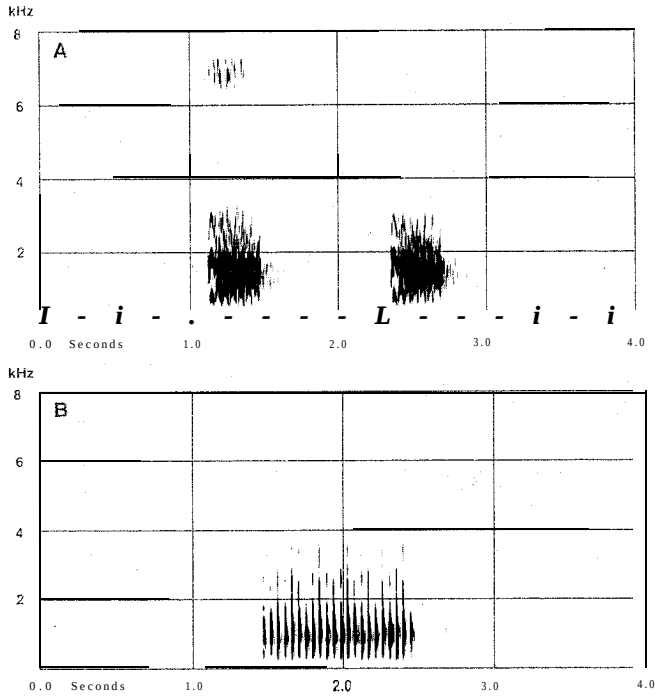

Figure 2. The *kwirr* call (A) and drumming (B) of the Red-bellied Woodpecker. Sonograms prepared by the staff of the Borror Laboratory of Bioacoustics (BLB), The Ohio State University (BLB no. 17910 [A], Fairfield Co., OH, 25 Apr 1991, and BLB No. 9764 [B], Franklin Co., OH, 9 Apr 1997). Prepared by staff of BLB using a Kay Elemetrics DSP 550 Sona-Graph (with an effective frequency resolution of 150 Hz and a 200 pt. FFT transform size).

when adults quietly slip in to feed young in the nest so as to not attract potential predators (REB).

Daily pattern. Vocal throughout the day, especially before and after roosting.

Places of vocalizing. Vocalizes during most of day from any perch site. Often vocalizes in flight (CES).

NONVOCAL SOUNDS

Commonly drums from a dead tree, dead stub, or utility pole; drums at 18.3-19.4 beats/s; duration 0.75–>1 s (Short 1982). In Madison Co., KY, from late Feb through late Oct, only males produced drums at an overall rate of 0.35 ± 1.63 SD/h of observation (Wilkins 1996). In that same study, drums consisted of an average of 12.92 hits ± 3.48 SD (n = 4 males; 76 drums). Often performs light drumming, called Tapping (see Breeding: sexual behavior, below).

Array of sounds. Woodpecker drumming is made when the bill rapidly strikes a hard surface, usually wood, but artificial structures are often used (e.g., metal roofs and street-light fixtures; CES; Fig. 2B).

Phenology. Birds drum year-round, but more frequently during the breeding season.

Daily pattern. Drumming occurs between actual or potential mates and can continue beyond the egg-laying period (Short 1982).

Places Of sound-making. Drumming occurs against surfaces that allow for optimum resonance: dead, hollow trees or stubs, utility pole, metal light fixtures, or other artificial surfaces.

Association of vocal and nonvocal sounds. *Kwirr* call is often alternated with drumming (Short 1982).

Social context andpresumedfinction. Drumming apparently used to proclaim a territory as well as for pair formation and maintenance (Stickel 1963b).

BEHAVIOR

LOCOMOTION

Walking, climbing, hopping, etc. Usually moves on tree trunks by "hitching"-alternating hops and pauses while scanning tree surfaces for food. Also moves down tree surfaces in the following manners: by angling body with an acute angle to the vertical with head upward, and hopping downward on trunk; by holding body horizontally and moving sideways down tree; or by hopping downward tail first while keeping body vertical and lifting tail at each downward hop (Boone 1963, Breitwisch 1977, REB).

Flight. Undulating, as with many woodpecker species. May fly short distances between foraging sites or may fly hundreds of meters between perches. Flights often begin with a launch from a perch in which the bird drops several feet before extending and beating its wings. Flights usually end in a glide with a slight downward dip, then a rapid upward glide to the perch. Boone (1963) reported that individuals sometimes hover briefly when obtaining berries or seeds. Bock (1970) calculated that the wing-loading of Red-bellied Woodpeckers was the highest of 5 woodpecker species measured.

Swimming and diving. Not known to occur.

SELF-MAINTENANCE

Preening, head-scratching, stretching, bathing, anting, etc. Apparently treat feathers with various substances (e.g., sand, unknown substances obtained from pine cones, bark) while preening; observed to preen in the following order: bend of wing, breast, shoulders, primaries (Hauser 1973). Head-scratching is direct, without lowering the wing; individual passes bill over oil gland at base of tail, rubs foot with bill, then lowers head to one side and scratches it (Kilham 1959). Stickel (1965b: 503) described stretching as follows: "First, a bird would extend both wings backward and downward, below the longitudinal axis of the body; the primaries at the culmination of the phase would be spread and would

extend beyond the tip of the tail. The bird would then return its wings to a normal position along the back. The second phase, which follows without any appreciable break, involved raising the wings so that they were perpendicular to the back, although the plane of the manus was still parallel to the longitudinal plane of the body." Kilham (1959) observed captive birds stretching one wing at a time. Wing-stretching normally includes stretching (fanning of) tail on same side of the body (J. Jackson pers. comm.).

Known to dust-bathe (Woolfenden 1975). Seen to bathe in water and to ant in N. Carolina in Apr, Jun, Sep, and Oct (Potter and Hauser 1974). One juvenile and 1 adult seen anting in conjunction with sunning in Sep (Hauser 1973).

Sunning typically occurs on trees, snags, and poles in full sun (Hauser 1957). Individual positions desired body parts toward the *sun,* raises crown feathers, cocks head to one side, opens bill, and stares at the sun with upper eye; may fluff contour feathers and fan tail and wings. Sunning is often interspersed with preening, stretching, and calling. May enter a stupor or state of lethargy while sunning (Woolfenden 1975).

Roosting information primarily from Stickel 1964: Adults roost singly in cavities at night, but juveniles roost in the open for at least the first few nights postfledging. Usually spends several minutes looking out of the roost cavity before leaving in the morning and repeats the behavior in the evening before settling into the cavity. Both sexes change roost cavities frequently, but may return at a later date to previously used cavities. Both sexes excavate cavities for roosting; these cavities shallower than those used for nesting. Individuals usually nest in a cavity excavated by the male for the purpose of roosting. An unusual winter roost situation was found in Florida, in which single-sex or both-sex groups of 2-4 Red-bellied Woodpeckers roosted under different fronds in the same cabbage palm (*Sabal palmetto*) trees (Saul and Wassmer 1983). Times of roosting are correlated with seasonal and weather-induced variation in photoperiod.

Daily time budget. Reller (1972) recorded the percent of time spent innest-attentiveness activities during breeding season in Illinois: 47.2% inside cavity, 36.9% guarding, 6.0% calling, 8.9% excavating, <1% changeover activities, <1% fighting (n = 18.27 h observation, at 10 nests). Nest attentiveness was greater during incubation and brooding periods than when young were near fledging (Jackson 1976b).

Askins (1983) recorded time budgets away from nest trees: in Maryland, 66.9% foraging, 32.3% resting and preening, and 0.8% other; in Minnesota, 62.3% foraging, 35.2% resting and preening, and 2.5% other. Askins (1983) also found that foraging occupied different proportions of the time budget at different times of the year: in Maryland, 72% of daylight time in autumn, 60% in early winter, and 72% in late winter; in Minnesota, 64% of time in summer and 60% of time in winter. See Food habits, feeding, above.

AGONISTIC BEHAVIOR

Physical interactions. Kilham (1961) stated that conflicts between two birds were invariably single-sex confrontations, but Breitwisch (1977) observed paired Red-bellied Woodpeckers chase away intruding conspecifics, regardless of sex, though the chasing was usually done by the male. During single-sex competitions for mates, nest holes, or territories, or during territorial boundary conflicts, birds may chase or fly at each other, which may result in body collisions or grappling with feet in the air (Kilham 1961, Boone 1963). During competitions, the resident individual often is the aggressor and attempts to chase same-sex conspecifics from the area. Stickel (1963b) observed a nesting female violently peck an intruding female when the latter poked her head into the nesting cavity.

Communicative interactions. Several levels of threat displays, depending on situation, are given by both sexes during conflicts over territories, nest holes, or mates.

PERCHED DISPLAY. In Red Enhancement display, excited birds, especially males, raise feathers of the crown and nape, causing red-feathered regions to be more visible and appear larger (see Fig. 3A; Kilham 1961, Boone 1963). The Stiff Pose results from an arched back and elevation of feathers covering the upper back and gives the bird a rigid, somewhat hump-backed appearance (Fig. 3B). In more intense interactions, the Full Threat display is given, with tail outspread and wings outstretched at an upward angle of 45" (Fig. 3C), or, in conflicts over holes, with wings spread out against the trunk of a tree (Kilham 1961).

FLIGHT DISPLAY. In the Floating Threat display, birds in flight appear to float through the air toward a given perch or toward a rival with wings held in the position of a Full Threat display (Kilham 1961).

SPACING

Territoriality. NATURE AND EXTENT OF TERRITORY. Most defensive of area immediately around nest cavity preceding and during breeding season, whether or not young or eggs are in the nest; a 6-9-m radius around the nest tree is usually vigorously defended, although conspecifics flying directly over the nest area typically do not arouse a response (Stickel 1965a, Breitwisch 1977). Species is

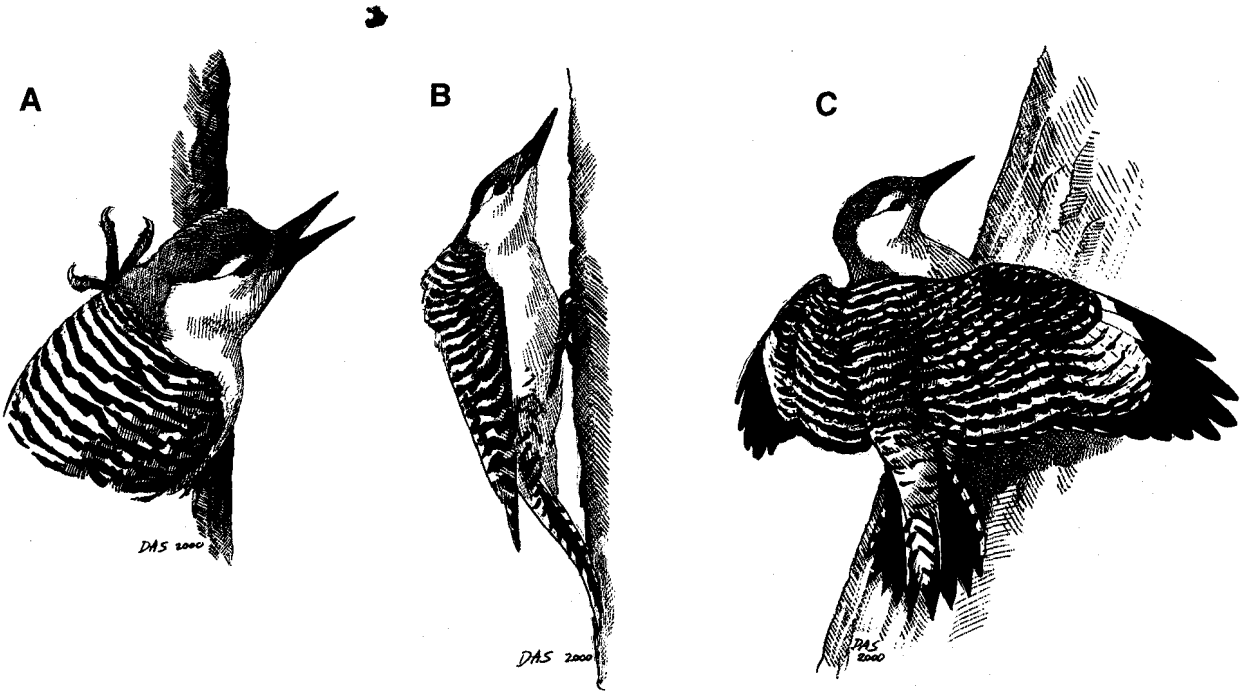

Figure 3. Perch Display of the Red-bellied Woodpecker. A. Raised feathers of crown and nape. B. Stiff Pose, showing hump-backed appearance. C. Full Threat display. Drawings by David Sibley.

decreasingly defensive farther from the nest, and foraging areas are only loosely defended (Stickel 1965a, Breitwisch 1977). Uses different parts of foraging area throughout the year because of opportunistic feeding on unevenly distributed and seasonally abundant fruits (Breitwisch 1977). After young leave nest, other conspecifics do not appear to interfere with parental feeding of young (Stickel 1963b). Territories are often limited by natural boundaries, including physiographic and biotic features such as woodland edges, fencerows, or streams; otherwise boundaries tend to be vaguely defined (Boone 1963).

Estimates of territory size vary widely and are likely affected by habitat quality and method of measurement. Published territory (foraging area) size estimates from various locations range from 1.6 to 16 ha (Fitch 1958, Williams 1975, Breitwisch 1977). Stickel (1963b) reported that the maximum territory size occasionally visited or traversed by a pair may be as much as twice as large as the regularly used territory and that vast areas within territories are rarely used.

Manner of Establishing and Maintaining Territory. Uses territorial calls *kwirr* and *cha-aa-ah* and drumming (see Sounds, above), often given from high perches by either sex, to establish and maintain territory. Neighboring birds often respond with the same call or drumming. Displays, chasing, and physical contact are used in territorial disputes (see Agonistic behavior, above).

Interspecific Territoriality. In the narrow zone of overlap of the two species' ranges around Austin, TX, Red-bellied and Golden-fronted woodpeckers maintain mutually exclusive, adjacent territories that they actively defend against each other (Selander and Giller 1959); both sexes of both species participated in interspecific territoriality, which, as typically defined, does not appear to occur with congeneric Red-headed Woodpeckers (*Melanerpes erythrocephulus)* according to Selander and Giller (1959). However, the relationship between the species is complex and the 2 may rival in areas of overlap, but Red-headeds typically succeed in battles over nest cavities (Nichols and Jackson 1987). Red-bellied Woodpecker has been recorded nesting in the same tree as other cavity-nesters, including Northern Flicker (*Colaptes auratus*), Red-headed Woodpecker, Hairy Woodpecker, and European Starling (*Sturnus vulgaris;* Stickel 1963a, Jackson 1977a, Ingold 1990).

There is a possibility that Red-headed and Red-bellied woodpeckers are kept apart in part by an interesting association between an acanthocephalan parasite that uses wood roaches as an intermediate host (Jackson and Nickol 1979). This parasite is common in Red-bellieds that live in mesic environments where wood roaches occur, but is unknown in Red-headeds that live in more open environments, where they do not generally feed on wood roaches (Jackson and Nickol 1979).

Winter Territoriality. Territorial boundaries break down at the end of the breeding season when

fledglings disperse but are re-established before the onset of winter. Males and females that previously paired together may occupy nonoverlapping or partially overlapping foraging areas, or may use the same foraging area but roost separately (Boone 1963, Stickel 1965a, Breitwisch 1977). In autumn, at the dissolution of the pair bond, members of a pair sometimes chase each other briefly, or give *kwirr* call to establish territorial boundaries (Stickel 1965a).

Members of a pair may rest motionless within a few centimeters of each other for several minutes at a time just prior to nesting, a behavior thought to be important for strengthening the pair bond (Kilham 1961). When foraging, Red-bellieds usually tolerate each other's proximity but may maintain distance by not foraging in the same tree simultaneously (Breitwisch 1977). Typically maintain greater individual distances during the nonbreeding season, but single-sex or both-sex groups of 2-4 birds were observed roosting singly in the same tree in Florida in winter, apparently without conflict (Saul and Wassmer 1983; see Self-maintenance, above).

SEXUAL BEHAVIOR

Mating system and sex ratio. Apparently (socially) monogamous, but little studied. No genetic data. Sex ratios not known, but approximately 1:1.

Pair bond. Pairs form any time from early winter to late spring; act of selecting a nest site is thought to be means of establishing the bond, with excavation acting to solidify it; the female'sacceptance of a cavity chiefly excavated by the male acts to maintain and further strengthen the pair bond (Kilham 1961, Stickel 1963b).

COURTSHIP DISPLAYS. Primarily adapted from Kilham (1958, 1961): Unmatedmalesapparently attempt to attract a mate by tapping alone, interspersed with *kwirr* calls and drumming (see Sounds: vocalizations, nonvocal sounds, above). Once a mate has been attracted, Mutual Tapping is important in nest-site selection and establishment of the pair bond; usually the male begins tapping (loudly but slowly, about 3 taps/s); if the female accepts the site, she joins him in tapping at the site. Mutual Tapping during excavationindicatesthefemale'scontinuedacceptance of the site and apparently serves to maintain the male's interest in excavating; if a female does not come to a cavity being excavated and engage in Mutual Tapping, the male will start excavating elsewhere (Stickel 1965a). Mutual Tapping may occur with both birds outside an excavation or with the male inside and the female outside, if the chamber has been sufficiently excavated. Mutual Tapping may occur far in advance of the breeding season.

COPULATION; PRE- AND POSTCOPULATORY DISPLAYS. Prior to copulation, male usually gives breeding *grr* call; female may mount male's back (reverse mounting; Hauser 1959,Kilham 1961, Stickel 1965a). Drumming by male and Mutual Tapping can apparently trigger copulation or reverse mounting early in the breeding season (Kilham 1958). Kilham (1961) described copulation in detail: Male mounts female directly after reverse mounting, sometimes briefly fluttering his wings; once established on her back, male falls down to left, then positions himself on his back with his body perpendicular to female's so that tails of the 2 birds overlap in cloacal contact. Copulation often culminates with the male spreading and flapping his wings and the female flying off (Stickel 1963b, Breitwisch 1977). Copulation takes place at highest frequencies just prior to egg-laying, but may take place ≥2 mo prior to egg-laying and continue into egg-laying, incubation, and nestling stages (e.g., Berger 1961, Stickel 1965a). Copulation in each pair typically takes place in 51 favorite spots (Kilham 1961, Stickel 1965a).

DURATION AND MAINTENANCE OF PAIR BOND. Depending on dates of initiation of pair bond and final nesting attempt of the season, pair bond may last ≥7 mo. *Kwirr* call and an intimate note, a low grr, *grr* are used to maintain the pair bond during the breeding season (Kilham 1958, 1961; Stickel 1965a). Mutual Tapping, reverse mounting, and resting motionless together, some of which may continue into the nestling stage, are important activities for maintaining the pair bond (Hauser 1959, Stickel 1965a, Reller 1972).

Extra-pair copulations. Not known to occur.

SOCIAL AND INTERSPECIFIC BEHAVIOR

Degree ofsociality. Largely solitary, except during breeding season when consorting with mate and nestlings or feeding recently fledged young. Not known to occur in groups. Holds territories or loose territories most of year exclusive of conspecifics, except mate (see Spacing, above).

Play. Kilham (1974) described several activities that he considered to be play. He observed wild birds suddenly fly erratically and dodge around and among trees, in the apparent absence of predators, in a manner similar to that employed to evade capturebyraptorialpredators(seePredation,below); this type of behavior is undoubtedly important for learning predator evasion. Possible play observed in captive birds included practice tapping by juveniles and storage of miscellaneous nonfood items by adults.

Nonpredatory interspecific interactions. *COMPETITION FOR FOOD.* Many interactions are related to direct or indirect competition for food. Observed to displace Yellow-bellied Sapsuckers from holes drilled in trees (sapsucker wells) and feed on sap

(McGuire 1932, Kilham 1963, Breitwisch 1977). Displaced a Blue Jay *(Cyanocitta cristata)* that was robbing its food stores, but quietly observed a Pileated Woodpecker *(Dryocopus pileatus)* engaged in the same activity (Kilham 1963). Downy Woodpeckers (*Picoides pubescens*), Northern Mockingbirds (*Mimus polyglottos*), and Blue Jays often displaced or chased Red-bellied Woodpeckers from trees the latter defended for foraging (Kilham 1958, Brcitwisch 1977, Ferguson 1977). Presence of Red-bellied Woodpeckers may cause Downy Woodpeckers to forage at lower positions in the canopy than otherwise (Williams 1975). Red-bellied Woodpeckers are usually near top of the hierarchy at feeding stations, about equal to Blue Jays but displacing other species (Breitwisch 1977, REB).

COMPETITION *FOR CAVITIES.* Competes for nesting and roosting cavities created by Red-cockaded Woodpeckers in living pines, and is able to use a Red-cockaded cavity without enlarging it (Jackson 1977a, Conner et al. 1997). Has been observed to peck at Red-cockadeds in cavities and grasp them with bill and drag them from cavities; can injure or kill a Red-cockaded when attempting to take over cavity (Ligon 1971). Cavity excavation in living pines can require several years and represents considerable effort by Red-cockadeds (Conner and Rudolph 1995); thus, loss of cavities to Red-bellied Woodpeckers is important.

Nest-cavity usurpation by European Starlings can significantly reduce Red-bellied Woodpecker reproductive success and cause a delay in breeding until later in the season (Ingold 1989a, 1994a) which may reduce a pair's chances of producing >1 brood/season. Contemporaneous nest initiation by Red-bellied Woodpeckers and European Starlings and lower levels of aggressiveness in nest defense cause Red-bellied Woodpeckers to experience higher cavity losses to starlings than other woodpeckers do (Ingold 1989a, Ingold and Densmore 1992). Studies by Ingold (1989a, 1994a) demonstrate the magnitude of cavity loss to other species: in Ohio, 21 of 54 (39%) Red-bellied Woodpecker cavities were usurped by European Starlings, 3 by Northern Flickers, 2 by southern flying squirrels (*Glaucomys volans*), and 1 by House Sparrows, for a total of 50% loss of cavities; in Mississippi, 55 of 105 (52%) cavities were usurped by European Starlings and 6 by Red-headed Woodpeckers; most loss of cavities occurred early in the breeding season. Occasionally, Red-bellied Woodpeckers are victorious in cavity competitions with European Starlings (Breitwisch 1977, Ingold 1989a, Baker and Payne 1993) and flying squirrels (Saul and Wassmer 1983), but more often forfeit the excavations to these more aggressive competitors. When a Red-bellied nest was usurped by European Starlings in Alabama, the former evicted a nearby nesting pair of Downy Woodpeckers and proceeded to nest there (Cardella 1997).

In Mississippi, 97% of (n = 66) interactions with Red-headed Woodpeckers involved only male Red-bellied Woodpeckers, but female Red-bellied Woodpeckers were involved 45% (n = 38) of the time in interactions with European Starlings (Ingold 1989a). Red-bellied and Golden-fronted woodpeckers are aggressive toward each other where their ranges overlap or are contiguous; known to dismember stuffed dummies of the other species placed near nest holes, suggesting that presence of Red-bellied Woodpeckers prevents the closely related Golden-fronted from expanding its range in Texas (although the area of overlap of the ranges of these 2 species has increased; Selander and Giller 1959).

PREDATION

of predators and manner of predation. Known predators of adults and fledged birds include Sharp-shinned Hawk *(Accipiter striatus)*, Cooper's Hawk (*A. cooperii*), black rat snake (*Elaphe o. obsoleta*), and house cat (*Felis domesticus;* Stickel 1962, 1963b, Saul 1983, Kirkpatrick 1994). The habit of nesting in cavities reduces nest predators to scansorial or flying animals. Known predators of eggs include Red-headed Woodpecker and European Starling (Sutton 1984, Jackson 1997). Known predators of nestlings include Pileated Woodpecker (Loftin 1981), gray rat snake *(E. o. spiloides;* Jackson 1977b, Ingold 1991), and black rat snake (Stickel 1963b).

Response to predators. In the presence of raptors and owls, they either harass predators with alarm calls or hide on the opposite side of trunks or limbs and remain still and quiet until the danger has passed (Boone 1963, Breitwisch 1977, REB, CES). Utter agitated *kwirr* calls and fly erratically into understory vegetation to evade capture when pursued by accipiters (Saul 1983). Individuals captured by Sharp-shinned Hawks are reported to thrash and screech loudly until incapacitated or released (Saul 1983, Kirkpatrick 1994). When captured in mist-nets, birds are excited, frightened, and hostile, and typically squeal loudly (Norris and Stamm 1965, RNC, CES). Humans climbing nest trees may elicit various mild responses, such as *kwirr* calls and drumming (Boone 1963, Breitwisch 1977). Usually respond to well-imitated Barred Owl *(Strix varia)* calls by immediately vocalizing, then flying closer in an attempt to locate the source of the calls (Shackelford 1994, Shackelford and Conner 1997).

Red-bellieds may aggressively defend young from nest predators. Stickel (1963a) observed a male and female repeatedly attack a southern flying squirrel roosting in a separate cavity in the nest

tree, each independently grabbing the squirrel with its bill and throwing it off the tree. A male Red-bellied Woodpecker at a Kansas nest swooped at and struck a black rat snake that was climbing to a nest with nestlings, forcing it to retreat (Boone 1963). Conversely, when a gray rat snake was in a lower cavity in a nest tree in Mississippi, a pair visited the nest just long enough to feed young, and the male repeatedly approached the snake within 1 m, but never struck it; the nest was eventually predated (Jackson 1977b).

BREEDING

PHENOLOGY

Pair formation. Males hold territories year-round, but females may compete for them early in the year (Kilham 1961). Rare to find mated pairs from Sep through Jan (Kilham 1958). Breeding activity in s. Illinois, for example, commences in Jan and Feb, with nesting beginning in Mar and Apr (Stickel 1963a). This agrees with mated pairs in Texas (Oberholser 1974, RNC).

Nest-building. In Mississippi, nests under construction Mar and Apr (Ingold 1989a, 198913).

First brood. Figure 4. Egg laying in s. Florida begins in Apr and extends past Jul into Aug (Breitwisch 1977). Earliest egg dates for above, 11 Apr; latest, 15 Aug. In Texas, eggs noted from 5 Apr to 9 Jul (Oberholser 1974). Egg dates, from earliest to latest known dates, include: 1 May-24 May in Virginia, 15 Apr-1 Jun in Indiana, 31 Mar-18 Aug in Florida, and 16 Apr-27 Jul in Alabama (Stickel 1963b). A more extensive list of range-wide egg dates occurs in Stickel 1963b.

In e.-central Mississippi, 65% of 27 nests studied were still in excavation phase of nesting cycle in Apr. This may have been due to a prolonged winter that year (Ingold 1989a). Almost fully-grown nestlings were seen being fed at nest hole entrance on late date of 27 Aug in New York (Crumb 1984).

Typically, nests only once, but 2 or 3 broods may be raised in southern part of species' range (Bent 1939). Three records of third clutches were noted in s. Florida (Breitwisch 1977). Willrenestif first attempt fails due to cavity competition (Ingold 1989a).

NEST SITE

Selection process. Red-bellied Woodpecker nest-site selection includes a ritualized behavior of mutual tapping (Kilham 1958). Observation suggests that the male woodpecker attempts to attract mate to his roost cavity or a partially completed excavation by means of *kwirr* calls, drumming, and relatively soft taps at a rate of 3/s (mutual tapping) while perched inside the cavity, or while perched on the outside of

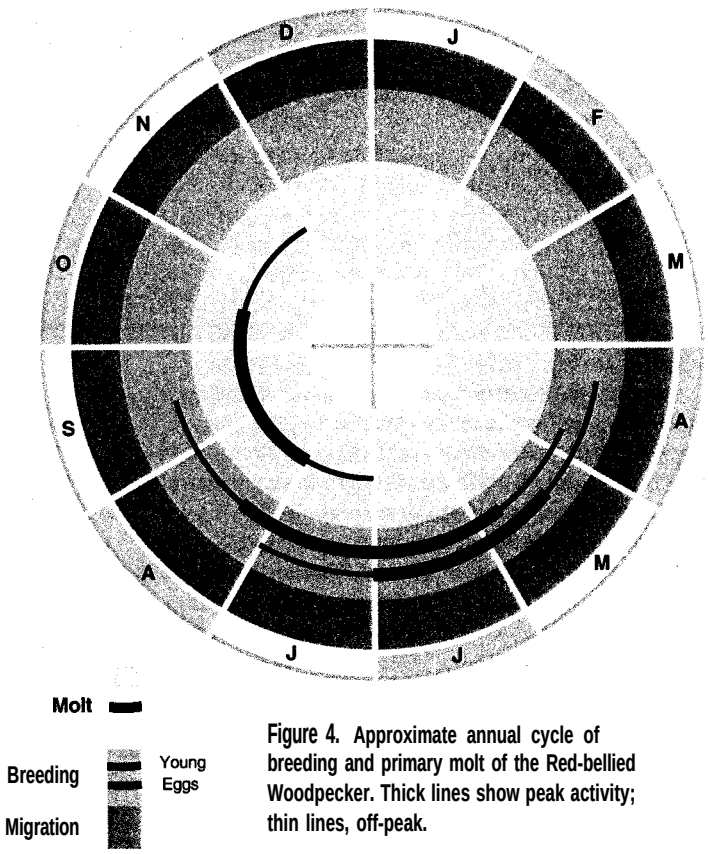

Figure 4. Approximate annual cycle of breeding and primary molt of the Red-bellied Woodpecker. Thick lines show peak activity; thin lines, off-peak.

the potential nest tree facing a partially excavated cavity. When attracted, the female flies to the male and perches beside him, joining him in nearly synchronous mutual tapping behavior (Kilham 1958), presumably indicating her acceptance of the site. If the cavity is partially completed, the mutual tapping behavior also appears to stimulate the female to help the male finish a nearly completed cavity.

Microhabitat. Generally selects dead trees (snags) or dead limbs in live trees, but fence posts are also readily used (Short 1982). A nest in Georgia was situated 2 m off the ground in a pine pole that was being used as midsection support for a cowshed roof (Deviney 1957). As sites for cavity excavation: in Kansas, 22 of 30 nests were in dead trees (Jackson 1976a); in Texas, 17 of 22 (RNC). In Illinois, by contrast, nests in dead trees in only 1 of 7 instances (Reller 1972).

Characteristically return to the same stub or limb to nest in successive years, but usually excavate a fresh cavity (Bent 1939, Jackson 1976b). In Ohio, 85% of nests used (n = 39) were freshly excavated (Ingold 1994b). Typically begin with a nest near the top of the stub, where water has filtered down and created suitable conditions with wood-decaying fungi for easier excavating (Jackson 1976b). The next year, the nest is usually below the previous

Table 1. Characteristics of Red-bellied Woodpecker nest trees in Kansas (Jackson 1976a), Illinois (Reller 1972), and Texas (RNC). Data given as mean ± SD (range).

	Kansas (n = 38)	Illinois (n = 7)	Texas (n = 22)
Height of nest tree (m)	9.9 ± 3.4 (5-18)		17.9 ± 7.1 (5.2–31)
Height of nest cavity (m)	7.6± 3.3 (2–18)	14.3 ± 4.8 (10-22)	13.3±5.7 (3–21)
Diameter at cavity (cm)	21.6 ± 8.9 (13-38)		26.0 ± 11.3 (17-70)

year's, and so on; common to find 3-4 cavities lined up along such a stub.

Red-bellied Woodpecker nests often have bark near the entrance; Red-headed Woodpecker nests rarely do (J. Jackson pers. comm.).

Tree species selected for nest sites include oaks (many species); hickories; maples; sweetgum; tupelo; hackberry; sycamore; ash; linden; elms; cottonwoods; pecans; and loblolly, shortleaf, and longleaf pines (Bent 1939, Reller 1972, Jackson 1976a). Often nest in live pines in cavities usurped from Red-cockaded Woodpeckers (Jackson 1977a, Kilham 1977).

Also known to excavate cavities and nest in utility poles and fence posts (Bent 1939, Dennis 1964). Nest trees range in height from 5 to 31 m (Ingold 1991; see Table 1). Cavitiesused for nesting are usually deeper than nonbreeding roost cavities (Stickell964). Nests in forest habitat with abundant ground vegetation more frequently than do Red-headed Woodpeckers and Northern Flickers (Ingold 1994b).

NEST

Construction process. Both sexes excavate nest cavities (Jackson 1976a; contra Kilham 1958, 1983). Nest cavities typically excavated on underside of limb or leaning tree trunk (Conner 1975, Jackson 1976a). No significant angular orientation reported (Reller 1972, Conner 1975). Can typically excavate a new nest cavity within 2 wk, although often ≥1 wk passes before first egg is laid (J. Jackson pers. comm.). One Red-bellied was able to excavate a cavity with a broken bill (Jackson 1975).

Method ofconstruction. Individual strikes tree with its bill, gradually chipping away a horizontal entrance tunnel to center of wood and then down for a vertical nest chamber for nesting or roosting. Cavity entrances slightly oval, averaging 5.9 cm horizontally and 5.7 cm vertically (Jackson 1976a).

Dimensions. Cavities range from 22 to 32 cm deep and are about 9 x 13 cm inside the tree (Jackson 1976a).

Microclimate. Chambers contain small chips of wood that fall to base of cavity as it is excavated (Jackson 1976a). Eggs are laid directly on these chips of wood.

EGGS

Shape. Subelliptical to long oval or elliptical (Baicich and Harrison 1997).

Size. Dimensions (mm) from Western Foundation of Vertebrate Zoology (WFVZ). *M. c. carolinus:* length 25.32 (range 22.45–28.29), breadth 18.80 (range 17.43-20.17; n = 20 clutches,'84 eggs). *M. c. harpaceus:* length 25.12 (range 22.17–28.34), breadth 19.11 (range 17.04-21.19; n = 16 clutches, 69 eggs). Similar for other subspecies.

Mass. No data on whole eggs; see below for mass of eggshell.

Texture and color. Smooth and slightly to moderately glossy white (Baicich and Harrison 1997).

Eggshell thickness. Empty shell weight(g) from WFVZ (no dates):M. *c. carolinus:* 0.349 (range 0.259–0.486; n = 20 clutches, 84 *eggs). M. c. harpaceus: 0.357* (range 0.256-0.468; n = 16 clutches, 69eggs). Similar range for other subspecies.

Clutch size. Range-wide mean of 4.18 *(n = 77;* WFVZ) and 4.31 ± 0.76 SD (n = 61; Koenig 1987). Within the family Picidae, clutch size correlates with morphological characters (e.g., Koenig 1987).

Egg-laying. Commences aftercavity is complete. Eggs are laid at l-d intervals (Jackson 1976b).

INCUBATION

Onset of broodiness and incubation in relation to laying. Full incubation generally begins after last egg has been laid (Jackson 1976a).

Incubation patch. Brood patch present on both sexes (Short 1982).

Incubation period. Incubation period approximately 12 d from laying of last egg until hatching of first egg in clutch, though last egg may hatch as much as 2 d later (Kilham 1961, Boone 1963, Jackson 1976a).

Parental behavior. C -over Activities. Both sexes incubate. Returning parent may fly directly to nest hole to relieve incubating parent or may perch nearby and call *kwirr,* causing the sitting

parent to emerge (Hauser 1959, Jackson 1976a). Nest exchanges are frequently accompanied by a chattering vocalization, sometimes by tapping by either parent (Kilham 1961, Reller 1972, Jackson 1976a). A parent entering the nest toincubateenters head first, walks head first down the entrance wall with feet spread far apart, turns while raising the tail out of the way, bares the brood patch, settles down over the eggs, and usually fluffs its feathers and relaxes its wings such that they rest on the bottom of the cavity (Jackson 1976a).

ROLES AND ATTENTION TO EGGS AND MATE. Male incubates at night (Stickel 1965a, Jackson 1976a). In individual pairs, either parent may perform most of the incubating (Kilham 1961, Boone 1963, Stickel 1965a), although these differences tend to average out; Stickel (1965a) found no significant difference between male and female incubating times when data from 9 Illinois nests were pooled. Females tend to incubate for longer periods than males during daylight hours, and male incubation times tend to be more brief but more frequent (Boone 1963, Stickel 1963b). In morning and during cool or rainy weather, both adults spend more time on eggs; during warmer weather, adults spend more time perched in or outside the nest hole, panting when hot (Stickel 1965a, Jackson 1977a). Adults wait to be relieved at nests significantly more often than they leave the nest without being relieved, indicating a high degree of attentiveness (Stickel 1965a).

INCUBATING RHYTHM AND ATTENTIVENESS PERIODS. Attentive periods observed by Jackson (1976a) in Kansas averaged 18.9 min (n = 16 individuals). Attentive periods observed by Stickel (1965a) in 2 Illinois pairs were 22.0 min ± 0.024 SE (SD = 0.25) for males and 32.5 ± 0.040 SE (SD = 0.36) for females; inattentive periods 29.0 ± 0.035 SE (SD = 0.36) for males and 29.0 ± 0.035 SE (SD = 0.31) for females; attentiveness in the Illinois pairs averaged 92% of daylight hours.

***Hardiness** of **eggs against temperature stress; effect** of egg neglect.* No information available.

HATCHING

Preliminary events and vocalizations. Nestlings vocalize while pipping (Stickel 1965a). Kilham (1961) reported that newly hatched nestlings utter a higher, more raspy, and discernible form of the adults' *churr, churr, churr (= kwirr)* when being fed.

Shell-breaking and emergence. Pipping takes approximately 2 h from beginning until chick is free from the egg (Stickel 1965a).

Parental assistance *and disposal* of *eggshells.* Boone (1963) reported that eggshells are rarely removed from the nest, and then only dropped at the base of the nest tree or nearby.

YOUNG BIRDS

Condition* at *hatching. Naked, closed eyes (Stickel 196313). Egg teeth conspicuous on upper and lower mandibles, with upper tooth larger (Stickel 1965a).

Growth and development. Adapted from Boone 1963 and Stickel 1963b: Average body mass at hatching = 8 g (*n* = 4). At 1 d old, nestling is naked with large protuberant abdomen, large folds of tissue present at corners of the mouth, eyes still closed, and egg teeth present. Tip of upper mandible and protuberant knobs at corners of bill are white; may serve to guide parents to bill of nestling in dark nest holes (Kilham 1961). When fed by parents, nestling props itself on abdomen and legs, spreads wings, and extends head and neck toward the nest opening; gives begging call. Despite having closed eyes, nestling detects changes in light intensity to sense adult returning with food (Jackson 1970, 1976b).

At 6 d, eyes begin to open and claws, rectrices, and remiges appear. Feathers on dorsal tracts appear at 8 d.

At 10–11 d, eyes almost completely open, feather sheaths protrude from skin, egg teeth still present, and folds at corners of mouth have decreased in size. Young capable of propping itself on its legs. Average total length 125 mm *(n = 17).*

At 15 d, eyes open, egg teeth less distinct, and folds at corners of mouth are almost gone. Sex is discernible from the faint red tinge of nape and crown feathers in males. Young can cling to vertical surface of nest-cavity walls. Average body mass 70.5 g (*n* = 5), average total length 157.5 mm (n = 8); primary feathers of wings 15-17 mm in length.

At 21 d, nestling is fully feathered and egg teeth and fleshy folds at comers of maxillae have disappeared. Can cling to walls of nest cavity and peer out, and give loud "location" calls; able to flutter about when released. Ceases gaining weight at this point (average 70.5 g; *n* = 5), but total length has increased to an average of 174 mm (n = 5). Intersibling conflicts may arise (Kilham 1961).

Vocalizations made by nestlings throughout development include harsh *kwirr* notes to solicit food from parents arriving at nest, and soft musical *wee-urp* notes after being fed; may make low *purp-purp-purp* sounds throughout much of the night (Kilham 1961).

PARENTAL CARE

Brooding. In Kansas, brooding periods averaged IO.4 min for first half of nestling period *(n = 37;* Jackson 1976a). Females spend more time brooding during daylight hours than males, but male broods nestlings every night until l-2 nights before fledging (Stickel 1965a, Jackson 1976a). During first week of

nestling stage, both adults brood and guard young, but this behavior decreases sharply later (Kilham 1961, Stickel 1965a).

From Kilham 1961, Stickel 1965a. Direct transfer of food carried in bill (not regurgitated). Feeding of young begins soon after hatching. First food items are small insects, which adults crush and break up before feeding young; nestlings are fed progressively larger items and fruits as they grow. Adults typically carry several insects or small fruits to nestlings each trip to nest. When nestlings are small, parents enter cavity to feed them; when larger, nestlings climb to cavity entrance and parents feed them from outside. Both parents typically leave nest quickly after feeding young when young near fledging.

In Kansas, both parents fed young with approximately equal frequency (48.3% [n = 28] and 51.7% of [n = 30] trips; females and males, respectively) for first 12 d; females fed somewhat more frequently than males thereafter (58.3% and 41.7%, respectively; Jackson 1976a). Feeding rates of young greatest from approximately 06:00 to ll:OO; lower from 11:00 to 16:00, then increase from 16:00 to 19:00 (Stickel 1965a). Frequency of feeding may reach 40-45 feedings/h both parents combined (Breitwisch 1977).

Following food items fed to nestlings in Kansas: wood roach (n = 10), mulberries (n = 6), beetle larvae (n = 3), spider (*n* = 1), lacewing (*n* = 1), moth (*n* = 1), and caterpillar (*n* = 1, Jackson 1976a). In New England, large adult beetles, butterflies, and unidentified insects; most of the arthropod prey items fed to nestlings obtained on tree trunks (Kilham 1961). In N. Carolina, earwigs, barkbeetles, caterpillars, and moths are delivered to nestlings (Duyckand McNair 1991). Inne. Kansas, mulberries were most common food item brought to nestlings; fragments of ≥1 of each of the following assumed food items found in a recently depredated nest: earthworm (Annelida), millipede (*Spriobolus* sp.), jumping spider (*Phidippus audax*), ground beetle (*Calosoma scrutator*), click beetle (*Melanctes piceus*), stag beetle (*Lucanus doma*), scarab beetle (*Euphoria fulgida*), stinkbugs (*Apeteticus bracteatus* and *Thyanta custator*), cicada (*Tibicen lyricen*), ants (*Camponotus herculaneus* and *Formica fusca*), and sphecid wasp (Larrinae; Boone 1963).

Nest ***sanitation.*** Only male observed removing excrement from nests, although both parents may consume fecal sacs at nests (Kilham 1961, Stickel 1965a). Brooding adults occasionally peck more chips from walls of the cavity for the first few days after eggs hatch, aiding in nest cleanliness. After first few days, no more wood chips are added and fecal material is not regularly removed, resulting in progressively unsanitary conditions; feces, food fragments, and egg shells collect in the nest with wood chips and begin to decay before the young fledge (Kilham 1961, Boone 1963, Jackson 1976a).

Carrying of young. Hickman (1970) reported an individual of unknown sex removing and carefully carrying an egg from a nest, though it is uncertain whether this bird was a parent of the egg (unbanded birds), and whether the egg was carried to a new nest site; this behavior may have been induced by disturbance by European Starlings, which eventually usurped the cavity. Roach (1975) observed a male carry 3 nestlings successively from a nest to an unknown location, though the function of this transport and the survival of the young were uncertain.

COOPERATIVE BREEDING

While not documented, there is 1 report of a strange nest situation involving 2 nests, 2 females and 1 male. Apparently, the same male was observed at both nests and the 2 females seemed to tolerate one another (Owens and Owens 1992).

BROOD PARASITISM

None documented.

FLEDGLING STAGE

Departure from nest. Occurs 24-27 d after hatching; all young may leave the nest on the same day or on 2 consecutive days (Boone 1963, Stickel 1965a). Kilham (1961) reported fledglings leaving the nest at 26 d for captive breeding birds. Fledging may be spontaneous, as parental behavior preceding fledging may not be appreciably different from normal (Stickel 1965a). Parents may stop or reduce feeding young at nest when they are ready to fledge (Kilham 1961).

Growth. No information available.

Association with parents or other young. Young begin following parents ≥2 d after fledging (Stickel 1965a). Nestlings usually divided between the parents (Kilham 1961, Breitwisch 1977). Use of various calls by juveniles enables parents to locate and feed the young (Stickel 1965a). Kilham (1961) reported that newly fledged birds beg with a soft *psee-chew*, in which the first syllable is high pitched; in succeeding weeks they use a *grr-ick, grr-ick* call.

Ability to get around, feed, and care for self, Fledglings are sedentary and skulking and may remain near the nest for the first few days after fledging; apparently fledglings do not roost in cavities at night for the first few nights (Stickel 1965a). Recently fledged young sometimes fall several feet after losing a foothold when trying to perch and have difficulty manipulating their tongues at first (Boone 1963). Juvenile birds have less coordinated movements than adults when foraging and tend to wedge their tails in bark when

hopping downward on tree trunks (Breitwisch 1977). Adults dismember large insects before feeding them to newly fledged juveniles (Kilham 1961), and may bring the fledglings to feeding stations to feed on seeds, suet, etc. (Mueller 1971).

Maximum period of postfledging dependency 5 wk in Kansas (Boone 1963); 6 wk estimated in Illinois (Stickel 1965a); nearly 10 wk in Maryland (Kilham 1961). Latitude and seasonal timing may affect the postfledging dependency period; this period usually lasted only 2-3 wk for nonfinal broods of the season, and up to 6 wk for the last brood of season in s. Florida (Breitwisch 1977). A second nesting attempt may limit the length of postfledging parental care. At the end of the dependency period, the adults, especially the male, become hostile toward the young and drive them from the territory (Boone 1963, Breitwisch 1977).

IMMATURE STAGE

Little known.

DEMOGRAPHY AND POPULATIONS

MEASURES OF BREEDING ACTIVITY

At first breeding; intervals between breeding. No data. Likely breeds in its first spring in the wild, since a pair in captivity did so (Kilham 1961).

Clutch. Four is most common (range 2-6). See Breeding: clutch size, above.

Annual and lifetime reproductive success. Few data; needs study. No data on hatching rates. In Kansas, fledging success (% young that leave nest out of eggs laid) was 55% (n = 18 clutches; Boone 1963). Nesting Red-bellied Woodpeckers that competed with European Starlings were less fecund than those that did not compete (Ingold 1989b). Red-bellied Woodpeckers nest earlier than Red-headed Woodpeckers in areas of overlap, but if those areas also supported European Starlings, then cavity competition would usually lead to late-nesting in Red-bellied Woodpeckers thus leading to nest-site competition with Red-headed Woodpeckers (Ingold 1989a).

Number of broods normally reared per season. Few data; needs study. 2-3 broods may be raised in the South, but only 1 successful brood is typical (Bent 1939, Kilham 1961). In northern parts of range, 2 broods raised in a single year noted in Connecticut (Sullivan 1992) and possibly in New York (Crumb 1984).

LIFE SPAN AND SURVIVORSHIP

Oldest documented individual: a male banded as a nestling and rediscovered in fine condition 12 yr and 1 mo later (Clapp et al. 1983).

DISEASE AND BODY PARASITES

Diseases. Limited information. *Plasmodium* sp., the organism causing malaria, has been reported in Red-bellied Woodpecker blood (Wetmore 1941). Jackson and Nickol (1979) give details on the ecology of an acanthocephalan parasite as it relates to Red-bellied nests (see Behavior: spacing, above). No data on causes of death in the National Wildlife Health Center database in Madison, WI (L. Creekmore pers. comm.).

Body parasites. Two species of lice have been found on live individuals (*Menacanthus precursor* and *Philopterus californiensis*; Peters 1936).

CAUSES OF MORTALITY

Predation. See Behavior: predation, above.

Competition with other species. Nest-site competition can be significant (see Behavior: social and interspecific, above). Individuals that bred where competition with European Starlings was high fledged fewer young than those living without such competition (Ingold 1989a, 1989b, see Measures of breeding activity: annual and lifetime reproductive success, above).

Other known mortality includes being stuck in pine resin at a Red-cockaded Woodpecker cavity, killed by European Starlings while defending cavity, hit by automobile, shot by humans, and killed in traps (Stickel 1963b, Bamett et al. 1983, Ingold 1989a). A severe windstorm blew a Red-bellied into a tree trunk with such force that it was impaled (Thompson 1994).

RANGE

Znitial dispersal from natal site. Adults drive juveniles from natal site in late summer or early fall of first year (Boone 1963). No data exist (e.g., radio-tracking studies) on how far juveniles travel before establishing their own territory. Of 61 banded nestlings in Mississippi, none returned to nest within 80 m of their fledging site (Ingold 1989a).

Fidelity to breeding site and winter home range. Males show strong site fidelity through the year and even a lifetime (Boone 1963). Do not maintain a year-round pair bond (Stickel 1963b). Pairs form or re-form and usually return to the same immediate nest site in subsequent years (Ingold 1991). Five color-banded adult males demonstrated some nest-site fidelity: 2 nested in the same tree for 2 and 3 yr, respectively; a third male nested within the same 400-m^2 area for 3 consecutive years; while 2 additional males nested in the same l-ha circular plot for 2 consecutive years (Ingold 1989a).

Dispersal from breeding site. Little information. Only 1 of 10 color-banded fledglings remained within its natal territory, while the other 9 were not seen again after their dispersal (Boone 1960).

Home ***range.*** In Illinois, 1 year-round resident covered an area (home range) of about 19 ha, another about 13 ha; only about 7 and 3 ha, respectively, were actively defended, however (Stickel 1963b). Mean 2.91 ± 2.05 SD individuals found in 3.5 ha of bottomland hardwood forest habitat in e. Texas (Shackelford and Conner 1997). This translates to almost 1 bird/ha in this preferred cover type.

POPULATION STATUS

Numbers. Nationwide population, Breeding Bird Survey (BBS) data showed a significant increasing trend from 1985 to 1991 (Price et al. 1995). Follow-ing states showed significant ($p < 0.01$) increases in Red-bellied populations from 1966 to 1998 (trend and sample size in parentheses): Connecticut (23.1, $n = 16$), New York (14.9, $n = 41$), Pennsylvania (10.4, $n = 80$), New Jersey (8.2, $n = 31$), Wisconsin (4.5, $n = 42$), Michigan (6.1, $n = 40$), West Virginia (2.9, $n = 44$; Sauer et al. 1999). Most robust populations found in se. U.S.-Mississippi River flood plain and s. Atlantic coastline (Sauer et al. 1999).

Of >100 species surveyed in all forest types in e. Texas (bottomland hardwood forests, mixed pine-hardwood forests, and longleaf pine Savannah), Red-bellied was 1 of 8 that was abundant in all forest types combined (Shackelford and Conner 1996). One of the most abundant and consistently detected birds in the Mississippi Alluvial Valley (Smith et al. 1993). Core of wintering individuals (Christmas Bird Count data) found in s. U.S., with fewer birds detected as one moves west toward 100°W and north to Canada (Bock and Lepthien 1975).

Trends. Sharp decline (35%) seen statewide in Pennsylvania Christmas Bird Counts (especially se. Pennsylvania Christmas Bird Counts) in 1990, possibly due to poor reproduction of young in the cold, wet breeding season of 1990 (Hess 1992). In an area where flooding killed timber in Illinois, Red-bellieds increased >100% in 8 yr owing to increased substrate for wood-boring beetles, a prime food source (Yeager 1955). Breeding population of Illinois nearly doubled from the early 1900s to the late 1950s and increased to the north over this time (Graber and Graber 1963).

BBS data show from 1966 to 1998 increasing trend in northern part of range, from s. Great Lakes region east to Pennsylvania, New York, and surrounding areas. Similar increases in Connecticut, Michigan, New Jersey, West Virginia, and Wisconsin (Sauer et al. 1999, see Numbers, above).

POPULATION REGULATION

No information.

CONSERVATION AND MANAGEMENT

EFFECTS OF HUMAN ACTIVITY

Shooting and trapping. Historically shot when foraging in fruit orchards and pecan groves (Bent 1939). Fruit is only a part of diet, however; individuals may return to same large fruit for several days, so only a minor nuisance to commercial fruit growers (Beal 1911, Breitwisch 1977). Few incidences of shooting in recent decades. During late 1980s, 7 shot in e. Texas and lined up along the highway as a protest against management for the Red-cockaded Woodpecker (RNC).

Pesticides and other contaminants. Occasionally nests in utility poles that are typically impregnated with creosote. Mortality of eggs and nestlings has been reported in such situations (Rumsey 1970). No other pesticide mortality known. Some brain cholinesterase inhibition, which can be lethal, was noted where a chemical application of pesticides was used in a pecan grove in Georgia (White and Seginak 1990).

White and Seginak (1990) showed that exposure to phosalone, an organophosphorus pesticide, caused only slight brain cholinesterase (ChE) inhibition in Red-bellied Woodpeckers. The effects on this species of exposure to disulfoton was inconclusive, as only 1 individual was located after pesticide application; however, Blue Jays in the same study area had moderate to severe reductions in ChE following disulfoton application, low enough to be diagnostic for cause of death.

Degradation of habitat. Not any "before and after" data when habitat altered. No doubt that this generalist does well in just about any wooded situation. Especially taken up residency in urban settings (see Habitat, above).

Disturbance at nest ***and roost sites.*** Usually tolerant of human activities near nest and roost sites. Species common in suburban and residential areas and regularly nests near backyards where human activity is high.

Direct human/research impacts. The effects of research activities are unknown, but likely minimal. Mortality resulting from mishandling during banding operations is a possibility, especially because the long, sticky, barbed tongue frequently becomes entangled in mist-nets.

MANAGEMENT

Not currently listed as threatened or endangered. In many areas where found in the Deep South, it is the most abundant woodpecker species present (Shackelford and Conner 1997). Because the species inhabits a wide variety of forest types of mid- to late-successional stages and nests in dead portions of live trees, the likelihood of it becoming threatened

or endangered is much lower than most other woodpecker species in North America.

Heavily dependent on moderately large snags (dead trees) for nest and roost sites; thus forest-management programs that actively remove or do not provide suitable-sized snags may limit this species. Will readily nest and roost in dead limbs on live hardwood trees, however, so presence of dead trees is not essential. The presence of mast-producing hardwoods and the provision of these trees by forest managers could benefit the woodpecker, particularly in bottomland hardwood forests during winter (Shackelford and Conner 1997).

APPEARANCE

MOLTS AND PLUMAGES

The following information based on Pyle 1997, except where stated, and refers to the species as a monotypic form after Short 1982. For characteristics of described subspecies, see Systematics: subspecies, and Systematics: related species, above.

Hatchlings. Born altricial and naked. See Breeding: young birds, above.

Juvenal plumage. Remiges and rectrices become visible at 6 d, while feather sheaths protrude from skin at 10–11 d. Fully feathered at 21 d. See Breeding: young birds, above.

Juvenal plumage is worn from May to Sep and is similar to Definitive Basic (adult) plumage, but duller overall. Also, the crown is dusky and there is no red on nape or nasal tufts, but males usually have ≥2 red feathers on the crown, while some females may have ≤2 red crown feathers. The zebra-patterned back is not distinctive, the rectrices are pointed and P10 is about 2 mm longer than in adults. The breast is finely streaked with dusky. Both sexes usually show a slight yellow-orange tint to the belly, more so in males than in females.

Basic Z plumage. Prebasic molt incomplete; occurs Aug–Oct. Prebasic I molt includes body feathers, 0 to most inner lesser- and median-coverts, occasionally l-6 inner greater-coverts, all primaries and rectrices, and O-6 inner secondaries, within S5 and S11 (usually l-4 feathers within S7–S10), but usually no primary-coverts. The replacement of secondaries occurs in about 26% of hatch-year birds, About 10% of hatch-year or second-year birds also retain 1–≥4 outer primaries during this molt.

Basic I plumage similar to Definitive Basic plumage.

Basic ZZ plumage. The second prebasic molt includes body feathers, all wing-coverts, rectrices, primaries, and secondaries (sometimes l-2 secondaries remain), but only l-5 outer primary-coverts.

Basic II plumage similar to Definitive Basic plumage.

Definitive Basic plumage. Definitive Prebasic molt usually complete, except some primary-coverts and, very rarely 1 or 2 secondaries, may be retained; molt occurs Jul–Oct.

. Lower forehead pinkish to reddish orange. Upper forehead and crown through uppermost back and sides of neck bright red (rarely orange or yellowish on nape), occasionally interrupted by gray feathering across central upper forehead. Back, scapulars, and rump black, barred white, becoming white with variable black streaks and bars on rump. Uppertail-coverts white, sometimes with a few indistinct black markings. Upper surface of rectrices black, central pair (R1) with white on inner web (generally with a few black marks), and outer pair with outer web barred black and white. Sides of head and neck (to just above eye) and remaining underparts gray to grayish white, becoming paler on superciliary and mustachial areas, tinged orange or pinkish (variable) on feathering from lores to cheeks and chin, somewhat darker on breast, and tinged olive, buff, or pink below throat. Central belly with pale pink or red (occasionally orange) patch (from which the name Red-bellied is derived) diffusely bordered by yellowish wash. Undertail-coverts with black V-shaped markings. Upper-wing-coverts, tertials, and secondaries black with white bars or spots. Primaries and primary-coverts black with large area of white at base of larger primaries, forming a white patch on the spread wing. Underwing gray with white patch on primaries and coverts barred gray and white. Undertail as uppertail but paler and grayer (Winkler et al. 1995).

Female. Similar to male except upper forehead and crown are gray (occasionally with few red feathers at center of crown), pinkish tinge on face less extensive, and belly patch smaller, paler, and with less reddish infusion (Winkler et al. 1995).

Aberrant plumages. Abnormally plumaged Red-bellieds (e.g., xanthic individuals) occasionally occur and have also been misidentified as Golden-fronteds, but a dorsal examination of the central rectrices is important: all-black in Golden-fronteds and black-and-white barring in Red-bellieds (Gerber 1986).

BARE PARTS

Bill and gape. Black in adults and horn-colored in immatures and juveniles. Gape color is a pale cream to yellow in juveniles (CES).

Iris. Dark brown (almost black) in both adults and juveniles (J. Jackson pers. comm.).

Legs ***and feet.*** Dark gray with black nails (CES).

MEASUREMENTS

LINEAR

As described by Pyle (1997); population not given:

Bill length. Exposed culmen in female: 25.4-29.9 mm (n = 40) and in male: 28.1–33.0 mm (n = 41).

Wing length. In females: 118-133 mm (n = 71) and in males: 122-139 mm (n = 100).

Tail length. In females: 68-84 mm (n = 40) and in males: 72-85 mm (n = 41).

Sexes are basically similar in size and overall appearance (except head color difference between sexes; see Appearance, above). Horny tip to tongue, however, varies in size by sex, which probably serves as a function of niche partitioning (Wallace 1974).

MASS

Body mass ranges from 56 to 91 g; males 8–9% heavier than females (Winkler et al. 1995). Specimens housed in the University of Miami Reference Collection, Coral Gables, FL, collected in s. Florida (seasons not given): male 61.4 g ± 8.96 SD (range 43.0-74.1; n = 21), and female 57.6 g ± 6.38 SD (range 43.6-67.9; n = 14; Breitwisch 1977). In Pennsylvania: 1 male collected in Jan weighed 80.3 g, while 1 ASY female collected in May weighed 74.5 g (Clench and Leberman 1978).

OTHER

Norris (1963) obtained blood-group data from 13 Red-bellied Woodpeckers, all of which were determined to have blood type 0. Antigen-reactivity index values resulting from reactions of erythrocytes to 10 standard antisera were given.

Henley et al. (1978) reported that Red-bellied Woodpecker spermatozoa were very different from the sperm of other oscines and more closely resembled that of fowl and ducks. The acrosome in spermatozoa of this species is more compact and button-like, and the nucleus is longer and more slender than that of oscines. Other information involving the spermatozoa and spermatogenesis in this species is also discussed.

PRIORITIES FOR FUTURE RESEARCH

Because forest fragmentation is increasing at an accelerating rate throughout the range of the Red-bellied Woodpecker, research is needed to evaluate the metapopulation dynamics of the species relative to source-sink populations. More information is also needed to determine how migratory habits of the woodpecker are affected by weather extremes and regional food shortages that may cause a southern shift of populations during some winters. A better understanding is also needed of the competitive impact of European Starlings on Red-bellied Woodpeckers and how this interaction might cause a shift in the timing of the breeding season for the woodpecker. As the land base that provides timber for human consumption shrinks in the future, increased demand for wood products will likely shorten timber harvest rotation and will affect the ages of trees available for nesting. Research is needed to determine nest-tree age thresholds for Red-bellied Woodpeckers to assure that forests are grown to sufficient ages to provide nesting sites. Research is also needed to explore the possibility of creating artificial snags for the woodpecker to alleviate problems associated with shortages of nesting sites that stem from intensive timber management and intense competition with other cavity nesters (Ingold 1989a, 1989b).

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