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The foraging behavior of six sympatric woodpecker species was studied between March 18 and April 24, 1975, in an oak-hickory woodland in Iowa City, Iowa. The six species of woodpeckers did not differ significantly in the parameter of mean foraging height, but did forage on different mean limb diameters. Other differences in foraging behavior noted between species were dead/live tree selection, sap utilization, and ground foraging. Significant differences in foraging behavior were also recorded between sexes of downy woodpeckers. Males tended to forage higher in trees and on smaller limbs than conspecific females.

INDEX DESCRIPTORS: Woodpecker foraging.

The comparative foraging behavior of woodpeckers has been studied by Selander and Giller (1959), Lawrence (1966), Ligon (1968), Willson (1970), Kisiel (1972), Reller (1972) and Williams (1975). In addition, sexual differences in foraging behavior for several woodpecker species have been shown by Kilham (1965, 1970), Selander (1966), Ligon (1968) and Williams (1975).

The concept of competitive exclusion (Hardin, 1960) suggests that similar, sympatric species should diverge to avoid competition. Divergence may also occur between sexes of a species, thereby reducing intraspecific competition (Selander, 1966; Schoener, 1967).

This study was designed to quantify the foraging behavior of six sympatric woodpeckers to determine what factors were important in interspecific segregation of the habitat. We were also interested in determining if intraspecific sexual dimorphism in foraging behavior allowed further habitat segregation. Specifically, the questions were: (1) Do different woodpecker species use different heights to forage? (2) Do the species utilize different trunk or branch diameters in foraging? (3) Do some species show a foraging preference for live or dead trees? (4) Are there intraspecific sexual differences in mean foraging height and/or limb diameter utilization? (5) Are there other observable distinctions in foraging behavior among species which may allow them to exploit a different food source?

METHODS

Field observations were conducted from March 18 to April 26, 1975, at Hickory Hill Park, Iowa City, Iowa. A total of 39 hours of field observation on 13 different days were recorded on six woodpecker species.

The study area was dominated by a mixture of white oak (*Quercus alba*) and shagbark (*Carya ovata*), bitternut (*Carya cordiformis*) and mockernut (*Carya tomentos*) hickory trees. Ten 50 ft.^{2} sample plots were chosen randomly in the study area to estimate the relative frequency of dead and live trees.

Woodpeckers were observed with 7 x 35 mm binoculars and the majority of observations were recorded in the morning on a portable tape recorder and transcribed later that day. Data were recorded only on foraging woodpeckers unless unusual inter- or intraspecific behavior was noted.

Observations were made along walkways maintained in the park and the heights and limb diameters of perches were estimated. Visual estimation was considered sufficiently accurate since Williams (1975) found significant differences in foraging heights by breaking observations down into large (10-foot) intervals. Measurements recorded the initial position of the woodpecker.

The following categories of data were recorded: (1) species and sex of woodpecker, (2) height above ground, (3) diameter of trunk or limb foraged, (4) condition of tree (dead or live) and (5) notes on foraging behavior.

RESULTS

Data consisted of observations on six woodpecker species including the downy woodpecker (*Dendrocopos pubescens*), hairy woodpecker (*Dendrocopos villosus*), red-headed woodpecker (*Melanerpes erythrocephalus*), yellow-bellied sapsucker (*Sphyrapicus varius*), red-bellied woodpecker (*Centurus carolinus*) and yellow-shafted flicker (*Colaptes auratus*).

There were significant differences in the frequency of foraging on dead trees among the six species (G test, $p < .01$). The red-bellied woodpeckers, red-headed woodpeckers and yellow-shafted flickers were often observed foraging at the broken ends of dead branches, resulting in an observed preference for dead trees (Table 1). The downy and hairy woodpeckers, along with the yellow-bellied sapsucker, were rarely observed on dead trees; observed frequencies were similar to the proportion of dead trees in the study area ($\sim$ 2%) as determined from ten 50 ft.^{2} sample quadrats.

Notes on the foraging behavior of the yellow-bellied sapsucker showed that, unlike the other woodpecker species, it commonly used sap as a food source. In 11 of 30 observations on their foraging behavior, sapsuckers were either feeding on sap or drilling horizontal series of holes to obtain sap.

The mean foraging heights of the six species (Table 1) did not prove to be significantly different among species when subjected to an analysis of variance ($F < 1$, Table 2). The yellow-shafted flicker, however, was commonly observed foraging on the ground (7 of 25 observations) while other species foraged exclusively in the trees.

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TABLE 1 SELECTED NICHE PARAMETERS FOR SIX WOODPECKER SPECIES

Species	*Percent of Observations on Dead Trees*	*$\bar{X}$ Foraging Height ± S.E. (n)*	*$\bar{X}$ Limb Diameter ± S.E. (n)*	*Significant Differences * in Limb Diameters ($p < .05$)*
Hairy Woodpecker	12.5	28.8 ± 5.07 (8)	2.57 ± .41 (7)	
Downy Woodpecker	8.0	31.3 ± 4.00 (53)	3.24 ± .39 (47)	
Yellow-Bellied Sapsucker	3.0	32.0 ± 1.92 (38)	4.21 ± .33 (33)	
Red-Headed Woodpecker	69.0	32.5 ± 2.86 (27)	5.05 ± .47 (20)	
Red-Bellied Woodpecker	48.0	22.7 ± 2.88 (26)	5.13 ± .82 (16)	
Yellow-Shafted Flicker	73.0	18.8 ± 2.85 (25)	5.81 ± 1.2 (8)	

*SNK test ($p < .05$).

TABLE 2 ANALYSIS OF VARIANCE OF FORAGING HEIGHTS

Source of Variation	*df*	*ss*	*ms*	*F*
Total	176	10223392.9		
Species	5	260908.7	52181.7	<1
Within Species (Error)	171	9962484.3	58260.1	

TABLE 3 ANALYSIS OF VARIANCE OF LIMB PERCH DIAMETERS

Source of Variation	*df*	*ss*	*ms*	*F*
Total	130	880.3		
Species	5	109.5	21.9	3.58
Within Species (Error)	125	770.83	6.12	

Although the mean foraging heights among species were not significantly different, a t-test showed a significant difference ($p < .01$) between mean foraging heights of male and female downy woodpeckers. Males, on the average, foraged higher on the tree (33.7 vs. 20.8 ft.) than females. On April 8, 13 and 20, male downy woodpeckers were observed displacing females to lower positions on tree trunks. On all three occasions the females had been foraging considerably higher (40-50 ft.) than their computed mean foraging height.

The mean limb diameters foraged by the six woodpecker species (Table 1) were significantly different among species when subjected to an analysis of variance (Table 3). *A posteriori* testing showed significant differences in limb diameters foraged between downies and, respectively, yellow-bellied and red-headed woodpeckers. However, the small sample sizes of the other species involved render other tests among individual species inadvisable. Downy woodpeckers also showed sexual divergence in mean limb diameter usage ($p < .05$). Therefore male downies foraged both higher and on smaller limbs than conspecific females.

DISCUSSION

Our data suggest that the six woodpecker species are not foraging at different heights, but are using dissimilar branch diameters in habitat segregation. Apparently the woodpeckers show considerable overlap in foraging height. Other factors such as tree species and/or insect selection may also be important in reducing interspecific competition.

Williams (1975), in a study in Illinois, showed that red-headed woodpeckers, downy woodpeckers, yellow-bellied sapsuckers and red-bellied woodpeckers do indeed display differences in both foraging height and limb diameter selection. However, his data also show a tremendous overlap among species in these parameters. If one assumes that prey density is high during the spring in northern latitudes, it is not surprising to find large niche overlap among woodpecker species. Baker and Baker (1973), in a study of six shorebird species, also found more niche overlap during periods of increased food density in the Arctic summer.

Several other trends in Williams' (1975) data were not observed in our study. In the Illinois woodland, red-headed woodpeckers were "specialists," hawking aerial insects and foraging on the ground, while downies were "generalists," drilling over a large range of tree heights and limb diameters. No such obvious differences were noted between the two species in the present study. The availability of dead trees and their utilization rate was greater in his study area. In Williams' report red-bellied woodpeckers were found on dead trees more than red-heads, and downies were found foraging on dead trees almost as often as red-heads; this also contrasted with our data (Table 1). Since there were differences among areas even in Williams' data, these current differences probably reflect area-specific behavioral flexibility, and may illustrate that niche dimensions in woodpeckers fluctuate drastically among different geographic regions.

It's also interesting that Williams found red-heads foraging on the ground, while in our study, where yellow-shafted flickers were also sympatric, this niche was occupied by the flickers. However, observations in the current study support Williams' notions that yellow-bellied sapsuckers are specializing on sap during migration and thereby possibly reducing interspecific competition.

Our conclusion that male downies forage on smaller limbs than females is supported by other studies (Jackson, 1970; Kisiel, 1972; Williams, 1975). Williams (1975), whose results were similar to our study, found that male downies foraged significantly higher in trees than females. Jackson (1970), however, found just the opposite. The fact that male and female downy woodpeckers diverged in foraging height and limb diameter usage may indicate that intraspecific rather than interspecific competition is more intense for this species.

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