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SPECIES USING RED-COCKADED WOODPECKER HOLES IN NORTHEASTERN SOUTH CAROLINA

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The sticky resin of pine and other plant resins have occasionally been reported as having a damaging or nuisance effect upon birds and other animals. Brodkorb (1928) reported an example of a Yellow-shafted Flicker (*Colaptes auratus*) losing its power of flight after contact with resin from a species of *populus* on the wings and tail. Ernest Cutts (pers. comm.) twice observed a dead bird stuck to the characteristic apron of resin that surrounds holes made by the Red-cockaded Woodpecker (*Dendrocopus borealis*). In one instance the victim was an Eastern Bluebird (*Sialia sialis*) and in the other probably a Pine Warbler (*Dendroica pinus*). Dennis (1969) reported that a house cat was apparently repelled by fresh resin at the entrance to a Yellow-shafted Flicker hole in a living white pine.

On the whole plant resins, however fresh and sticky they may be, do not seem seriously to impede or harm higher forms of life. Even the "intentional" barriers of resin established by Red-breasted Nuthatches (*Sitta canadensis*) and the Red-cockaded Woodpeckers about certain of their holes do not appear to be effective in keeping out most intruders. Rand (1959) suggests that in the Red-breasted Nuthatch the habit is an archaic trait that no longer serves a useful purpose. The nuthatch carries droplets of fresh resin in its bill to its nesting site and smears this material around the outside of the hole opening. The Red-cockaded Woodpecker, on the other hand, makes an elaborate network of diggings on the trunk, and sometimes the branches, of the living pine in which it makes its roosting and nesting holes. Each digging is roughly circular, about an inch in diameter, and penetrates into the sapwood. The pit that is formed exudes both sap and resin.

Trunks of pines utilized by Red-cockaded Woodpeckers are commonly worked with resin pits for a distance of two or three feet above to five or ten feet below a hole opening. Diggings generally extend all the way around the trunk but are more concentrated on the face containing a hole opening. The resin that flows from such workings tends to congeal upon the tree trunk; some of it may splatter leaves and needles of nearby trees, and even the ground below a tree trunk may become heavily matted. Faces of neighboring pine trunks opposite hole openings are sometimes

treated in the same way. Other nearby pines may receive a less severe treatment in the form of numerous small sapsucker-like holes. These holes are irregularly arranged and not in the neat parallel rows characteristic of the work of sapsuckers (*Sphyrapicus*). The reason for this sapsucker-like work by the Red-cockaded Woodpecker is not known.

The more elaborate diggings of the Red-cockaded Woodpecker have been called "a sticky and effective barrier against ants and flying squirrels" (Pearson *et al.*, 1942), and much the same conclusion was reached by Steirly (1957). Dennis (1968), noting the frequency with which the Red-cockaded Woodpecker is harassed by the Red-bellied Woodpecker (*Centurus carolinus*) and other woodpecker species, concluded that resin workings were primarily a defense against avian usurpers. Ligon (1970) suggested protection from snakes and "certain other animals."

OBSERVATIONS AT A STUDY AREA

One of the few parts of its range where the Red-cockaded Woodpecker is at all plentiful is coastal South Carolina from about the vicinity of Charleston northward. The dependence of the Red-cockaded upon living pine with red heart (*Fomes pini*) is well known. Beckett and Cutts (pers. comm.) claim that the bird some times excavates cavities in living pine not infected with red heart. However this may be, the destruction of older pine—generally much more susceptible to red heart than younger trees—is believed to be the major cause of a drastic decrease in Red-cockaded numbers during this century.

Poor drainage, presence of a hard pan near the surface, and poor soil conditions generally have made for unusually slow growth in pine in many coastal areas of South Carolina. Various stands containing suppressed pine from 90 to 150 years of age and often heavily infected with red heart exist near the coast between Georgetown and Myrtle Beach, South Carolina. Good Red-cockaded populations frequent some of these stands. The writer made detailed observations at one such area at the northern outskirts of Myrtle Beach during the winter and early nesting season of 1970. Pines in this area were dominantly long-leaf (*Pinus palustris*), rarely over 18.0 inches in diameter as measured at breast height, and growing in open park-like stands. These pine woodlands were at edges of residential areas, adjacent to golf courses, and, in some cases, along heavily travelled highways.

The main purpose of this study was to ascertain utilization of holes by species other than the Red-cockaded Woodpecker; also it was of interest to find out if resin either in a dry or sticky state had a protective effect in keeping out ants, reptiles, mammals, or other birds. A total of 69 Red-cockaded holes (deep enough to be used by cavity nesting birds) were found in 60 living pines. Sites were checked on a weekly schedule. All but highest sites were reached with the aid of an extension ladder.

Sites at the study area were classified as follows:

(1) Actively used by Red-cockaded Woodpecker—resin fresh, sticky, and always in copious supply around the hole opening—15 sites.

(2) Some use by Red-cockaded Woodpecker as roosting holes or recently abandoned—resin smooth, whitish, but little if any stickiness—27 sites.

(3) Long abandoned by Red-cockaded Woodpecker—resin cracking, yellow, and very hard—27 sites.

Usage recorded at the 69 sites was as follows:

	<i>No. Sites</i>	<i>Per Cent</i>
Very little or no usage	25	36.2
Nesting Red-cockaded Woodpecker	12	17.4
Exclusive use by flying squirrel	9	11.6
Successive users		
Flying squirrel—Red-cockaded Woodpecker	2	
Red-cockaded Woodpecker—flying squirrel	1	
Flying squirrel—gray squirrel	1	
Flying squirrel—Flicker	1	
Flying squirrel—Red-headed Woodpecker	1	
Flying squirrel—Crested Flycatcher	1	
Flying squirrel—honey bee	1	
Starling—Red-headed Woodpecker	1	
Other users		
Gray squirrel	2	
Red-bellied Woodpecker	1	
Red-headed Woodpecker	1	
Tufted Titmouse	1	
Yellow-shafted Flicker	1	
Wasp	1	
Recent enlarging Pileated Woodpecker	7	
	<hr/> 69	

Sites showing very little or no usage were largely long-abandoned ones in group No. 3. Entrances to many had been enlarged by Pileated Woodpeckers (*Dryocopus pileatus*), other woodpeckers, or flying squirrels. Nearly all of the sites in this group showed past

or recent signs of usage by flying squirrels. In addition, a few were receiving occasional uses as roosting sites by woodpeckers.

All of the 12 sites used for nesting by Red-cockaded Woodpeckers were copiously protected by fresh resin. Once Red-cockaded nesting was underway, none of these sites was observed to have been taken by other species. Several were "watched" by Flickers, Red-bellied Woodpeckers, or Red-headed Woodpeckers (*Melanerpes erythrocephalus*). A Flicker, attempting to enlarge the entrance to one of the active nesting sites, was seen to experience possible discomfort. On leaving off from this work, the bird made repeated but apparently futile efforts to wipe sticky resin from its bill.

Successful defense of nesting sites by Red-cockaded Woodpeckers seemed to depend more upon threat displays and aggressive tactics than in reliance upon resin. Intruders invariably departed on being confronted by one or both members of a nesting pair. A Red-cockaded Woodpecker lodged inside the entrance to its cavity is a formidable antagonist. More than once the writer has been startled by the reptile-like appearance of a Red-cockaded's head facing outward at a cavity entrance.

Flying squirrels were by far the most frequent users of Red-cockaded holes. Nine sites were used exclusively by flying squirrels and eight sites had a record of usage by flying squirrels and some other species. Thus approximately one-quarter of the Red-cockaded holes in the study area had a record of extensive use by flying squirrels. An additional ten to fifteen holes appeared to receive occasional flying squirrel usage.

Eight of the nine sites having two successive users had a record of flying squirrel occupancy. In seven instances sites that were used by flying squirrels during the winter were taken by some other species during the spring nesting season. In one instance the reverse occurred; a hole used for roosting by a Red-cockaded Woodpecker during the winter was occupied during the spring by flying squirrels. The following nested in sites that had been used by flying squirrels during the preceding winter: Red-cockaded Woodpecker (two examples), Yellow-shafted Flicker, Red-headed Woodpecker, and Crested Flycatcher (*Myiarchus crinitus*). At one site Red-headed Woodpeckers were the occupants after Starlings (*Sturnus vulgaris*) had finished with nesting.

Sites no longer used by Red-cockaded Woodpeckers that had only one occupant were as follows: gray squirrel (*Sciurus carolinensis*) two sites, Red-bellied Woodpecker one site for roosting, Red-headed Woodpecker, Tufted Titmouse (*Parus bicolor*), and Yellow-shafted Flicker, each, one site for nesting, and wasp (sp.?) one site.

Seven sites showed signs of recent enlarging by Pileated Woodpeckers. Also many of the trees listed as used by Red-cockaded Woodpeckers or other occupants contained signs of Pileated activity. Usually this attention was limited to gashes or slits in the tree trunk a foot or so above a hole opening but not necessarily on the same side as the opening. As with Red-cockaded diggings these gashes often exuded copious quantities of resin. In all, some

24, or 40 per cent of the pines with Red-cockaded holes, contained signs of recent or old Pileated activity.

Widening of entrances (often accompanied by enlargement of cavities) was noted at some 15 sites. At eight sites hole openings had been widened by between five to seven and one-half inches (vertical dimensions) and four to six inches (horizontal dimensions). These dimensions are considerably greater than those given for nest cavity openings of the northern race of the Pileated Woodpecker (Bent, 1939).

Enlarging of this kind made a number of sites available to occupants, such as gray squirrel and raccoon (*Procyon lotor*), that could not have utilized the smaller openings and interiors typical of the Red-cockaded Woodpecker. On the other hand, about half the sites hollowed out by the Pileated Woodpecker were rendered useless by flooding with rain water. One site had been rendered useless by deposits of sticky resin that had streamed in through the greatly enlarged entrance. The small opening and upward sloping entrance of the Red-cockaded Woodpecker are adaptations that prevent this kind of despoilation. One suspects that the Pileated Woodpecker lacks the finesse to turn very many Red-cockaded sites into suitable roosting or nesting cavities for its own use. There was no evidence that any of the enlarged Red-cockaded sites at the Myrtle Beach study area were ever used for any functional purpose by the Pileated Woodpecker. Activity by this large woodpecker in living pine is highly destructive in nature, thus adding another obstacle to the success of a species already hard pressed for living quarters.

Probably all of the cavity nesting birds of Southeastern pine woodlands are to be looked for as users of intact or enlarged Red-cockaded cavities. Other species, besides those mentioned, using Red-cockaded cavities for nesting in northeastern South Carolina were Red-bellied Woodpecker, Carolina Chickadee (*Parus carolinensis*), White-breasted Nuthatch (*Sitta carolinensis*), and Eastern Bluebird. Presence of raccoon hair in a greatly enlarged cavity in the study area suggested past usage by an individual of this species.

PREDATION BY YELLOW RAT SNAKE

In mid-afternoon on 29 March 1970, the writer happened upon a yellow rat snake (*Elaphe obsoleta quadrivittata*) as it attempted to reach a Red-cockaded cavity occupied by one or more flying squirrels. The opening to the northwest was at 13 feet on the branchless trunk of a living longleaf pine. When first observed, the snake was at the base of the trunk and slowly making its way upward. Shortly a flying squirrel appeared at the entrance to the hole. Only its head showing, it remained immovable as though paralyzed by fear. The snake, about four feet long, meanwhile was having difficulty working its way over the smooth apron of dry resin that covered much of the tree trunk from a distance of five feet below the hole to two feet above it.

Judging from the hardness and dryness of the resin, the tree had not been worked by a Red-cockaded Woodpecker for several months. A small accumulation of fresh resin directly below the hole was probably to be attributed to flying squirrel gnawing around the hole entrance.

Slowly inching its way upward, the snake finally gained a position whereby its head was only two or three inches from the still immobile and transfixed flying squirrel. At this crucial moment the snake lost its grip upon the smooth resin-coated bark and fell to the ground. The drama was not at an end. The snake, making a second try (perhaps there had been other ones before this), began ascending the tree trunk again. This time its ascent was largely on the opposite side of the trunk. Here there were fewer resin wells and consequently the bark was rougher. Taking advantage of this condition, the snake worked its way well above the hole entrance and then circling around to the hole side, began making its way downward over the foot or so of surface separating it from the opening. The flying squirrel, whose paralysis had now lasted some twenty-five minutes, suddenly popped back into the hole and disappeared from sight. This occurred when the snake's head was again only a few inches away. The snake, now gathering up its length, suddenly made a lunge which took half its body inside the cavity. Slowly the rest of its body disappeared into the cavity. Seven days later the snake was observed still to be in the cavity and now with its head facing outward at the entrance.

Rat snakes are known as excellent climbers; therefore this snake's difficulties in reaching the cavity opening could only have been a result of poor traction on a smooth resinous surface. Jackson (1970) tells of a black rat snake successfully climbing the smooth, barkless trunk of a dead American elm to reach a Flicker's nest.

COMPASS DIRECTION OF OPENINGS

In a sample of 362 hole openings from northeastern South Carolina, 266 or 73.5 percent were oriented in a westerly direction and 37 or 10.0 per cent in an easterly direction. This was in striking contrast to orientation of hole openings of other woodpecker species for which data are available. Lawrence (1966), for example, reported that only 22.5 per cent of openings of four woodpecker species in the Pimisi Bay Region of Ontario had a westerly orientation; in contrast 43 per cent had an easterly orientation. Similar findings have been reported for the Yellow-shafted Flicker on Nantucket (Dennis, 1969) and the Pileated Woodpecker (Bent, 1939, Dennis, 1969).

Easterly and also southerly orientations have been suggested as adaptations to obtain the greatest amount possible of early-morning warmth and light at the hole opening (Lawrence, 1966). Other considerations would appear to be more important to the Red-cockaded Woodpecker. It is suggested that this species orients its hole in a westerly direction in order to expose resinous surfaces near the opening to the longest periods possible of daylight

sunshine and warmth.

A westerly orientation is noticeably more pronounced toward northern limits of the range. For example, in 31 sites from north-central Florida, 51.6 per cent had a westerly exposure; but in 36 sites from southeastern Virginia and northeastern North Carolina, no less than 87.8 per cent of openings had a westerly exposure. A tendency toward a greater incidence of westerly exposure toward northern limits of the range would be in keeping with climatic conditions less favorable for the creation of a soft gummy surface.

Direction of hole openings at the 362 sites in South Carolina were as follows:

N	NW	W	SW	S	SE	E	NE
35	88	107	71	24	10	7	20

DISCUSSION

There was no evidence that the resin workings of the Red-cockaded Woodpecker are a device to protect the cavity from ants. Both the writer and Beckett (pers. comm.) have frequently seen ants crossing sticky patches of resin. Why woodpeckers, that on the whole are major avian predators upon ants, should have to defend their holes against this form of life, has to this writer's knowledge never been explained. Several Old World woodpeckers actually raise their young in occupied ants' nests (Baker, 1927), and presumably without any ill effect to young or adults.

That flying squirrels are serious competitors for Red-cockaded holes is well known to everyone who has studied this woodpecker. Although flying squirrels were not seen using excessively sticky sites at Myrtle Beach, the writer did observe two flying squirrels at an extremely sticky Red-cockaded hole in Texas. Beckett (pers. comm.) has several times caught in mist nets flying squirrels that had just emerged from relatively sticky Red-cockaded holes. The only resin on these animals was on the feet. It would appear that pine resin, no matter how sticky, is totally ineffective as a barrier against flying squirrels.

Other birds, on the whole, seem to be little deterred by the presence of either fresh or old resin. Beckett (pers. comm.) has noted several examples of Eastern Bluebirds taking over sticky cavities immediately after they had been vacated by families of Red-cockaded Woodpeckers. He also observed the same thing with a pair of Red-bellied Woodpeckers and another of Red-headed Woodpeckers. Both these species show a tendency to "wait out" Red-cockaded Woodpeckers at their sites even though this may delay them well beyond their normal nesting times.

The writer (Dennis, 1968) must revise his conclusion that resin is used by the Red-cockaded Woodpecker mainly as a protectant against other woodpeckers and hole nesting birds generally. Other birds are apparently not seriously deterred by presence of fresh resin.

The example of a tree climbing snake falling from a site protected

by a coating of smooth, largely dry resin suggests that snakes may be the main antagonists that the Red-cockaded fortifies itself against. The fact that the trunk is characteristically chipped on all sides, and that nearby pine trees, that could be used by snakes as bridges, are also chipped would seem to lend support to this theory. Many more observations are needed and with careful attention to how snakes react to resinous surfaces of various ages and degrees of stickiness.

SUMMARY AND CONCLUSIONS

1. The resin diggings of the Red-cockaded Woodpecker are located on the trunk and sometimes branches of living pine containing nest or roost holes; such workings are most heavily concentrated about hole openings and from a distance of two or three feet above to five or ten feet below an opening; nearby faces of living pine are sometimes worked, and, in addition, a functionally different kind of boring is sometimes seen in nearby pine.

2. Detailed observations were made during the winter and spring of 1970 at 69 Red-cockaded holes in 60 living pines in woodlands at the northern edge of Myrtle Beach, South Carolina.

3. Flying squirrels occupied one-fourth of the holes and made occasional use of another ten to fifteen.

4. Nesting Red-cockaded Woodpeckers used 12 holes, or 17.4 per cent of those present.

5. Nine holes had two successive users; with only one exception flying squirrels were one of the users. In seven instances flying squirrels present during the winter were superseded by another species during the spring nesting season.

6. Pileated Woodpeckers were present at seven holes during the study period; in all some 24, or 40 per cent of the pines with Red-cockaded holes, contained signs of recent or old Pileated activity. Pileated work varied from small gashes near hole openings to drastic enlargements of openings and cavities.

7. Pileated Woodpeckers were not observed using any of these cavities; a number were rendered worthless by flooding with rain water. Loss of cavities through Pileated Woodpecker depredation is a significant factor in reducing the number of sites available to the hard-pressed Red-cockaded Woodpecker.

8. Birds using Red-cockaded sites for nesting at the Myrtle Beach study area included Yellow-shafted Flicker, Red-headed Woodpecker, Crested Flycatcher, Tufted Titmouse, and Starling. Other species using such holes for nesting in the same general area were Red-bellied Woodpecker, Carolina Chickadee, White-breasted Nuthatch, and Eastern Bluebird.

9. A yellow rat snake was observed on a second try to reach a Red-cockaded cavity containing one or more flying squirrels. Slipperiness of dry pine resin was a factor in retarding the snake

in its efforts to reach the hole.

10. In a sample of 362 Red-cockaded hole openings from northeastern South Carolina, 73.5 per cent were oriented in a westerly direction; this contrasts sharply with more easterly and southerly orientations found in several other woodpecker species. The westerly orientation appears to be considerably more pronounced toward northern limits of the range.

11. The resin diggings of the Red-cockaded Woodpecker appear to be primarily an adaptation to keep snakes from holes; there is little indication that such workings are effective in preventing take-over of holes by other intruders.

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