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ARTIFICIAL SNAGS AS NESTING SITES FOR CHICKADEES[1]

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Chickadees and titmice are abundant permanent residents that nest in tree cavities. These attributes have made them attractive subjects for study in the heavily managed woodlands of western Europe, where natural cavity sites are rare. Under such circumstances, parids nest readily in nest boxes, fostering a continual stream of experimental projects and long-term demographic studies (e.g., Perrins 1979, Perrins and McCleery 1989, Dhondt 1989, Hogstad 1989).

Compared with those of western Europe, the woodlands of North America are vast and not intensively managed. Cavities and potential cavity sites are usually abundant and, with a few exceptions in coniferous forests of the West (e.g., Dahlsten and Copper 1979, McCallum 1990), attempts to establish nest-box study systems for parids have failed, presumably because the birds' preferences for certain attributes of cavities are better met by natural sites. Therefore, whereas European parids are perhaps the best-studied group of wild, non-game birds in the world, much less is known about their North American congeners (e.g., Grubb and Pravosudov 1994). Here, we introduce an artificial nesting structure (hereafter referred to as a "snag") that appears

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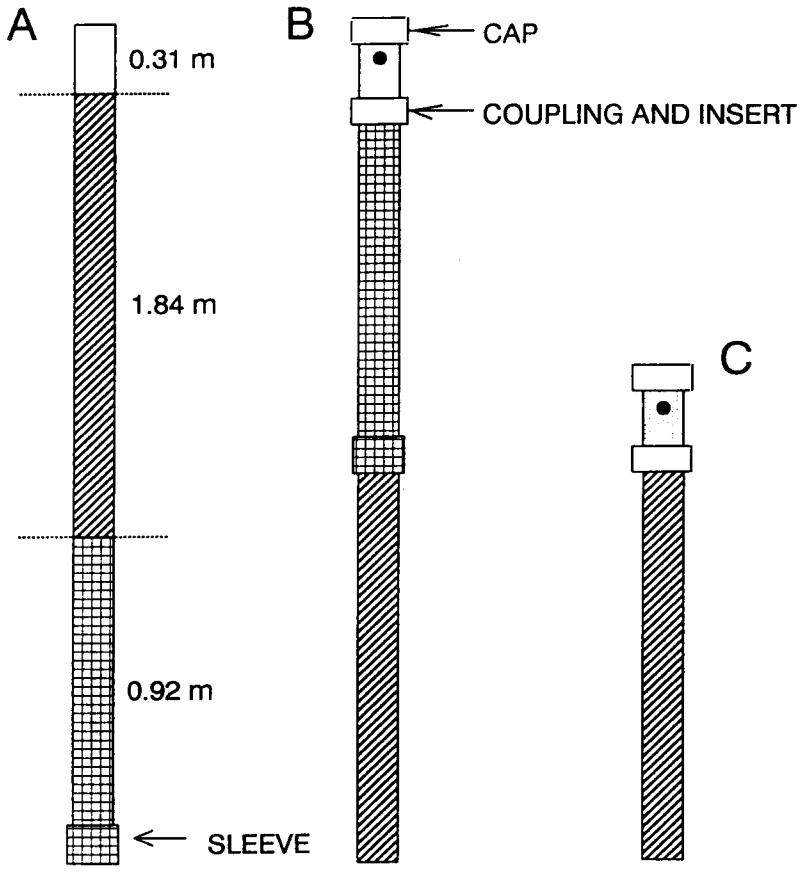

FIGURE 1. Artificial snag designed for roosting and nesting chickadees. The dashed lines in A illustrate where to cut each 3.08-m-long by 7.80-cm-inside-diameter thin-wall plastic PVC pipe. The arrangement of the three sections of a snag (depicted by different fill patterns) is shown in B. The plastic insert for the bottom of the nest chamber is cemented between the top section and the coupling. Temporary removal of the middle snag section to lower the nest chamber for efficient mist-netting of adults feeding nestlings is shown in C.

to be highly attractive to North American chickadees, even those living in essentially unmanaged woodland.

From our observations and from Albano's (1992) findings, we concluded that the Black-capped (*Parus atricapillus*) and Carolina (*P. carolinensis*) Chickadees we study in Ohio are maximally attracted to cavity sites with the following attributes: (1) small diameter, possibly because of less competition for such sites from larger birds; (2) hard outer surface or "shell," presumably because such sites are more resistant to nest predators; and (3) considerable height above the ground, presumably related to Albano's (1992) finding that nest loss to predation is inversely correlated with height. Here, we present results pertaining to the usage and reproductive success observed in artificial snags designed to possess such attractive characteristics. Additionally, we evaluate chickadee nesting preferences in relation to a snag's surrounding vegetation, location within a woodlot, and whether cavity excavation was required.

METHODS

We fashioned the snags from 7.80-cm inside-diameter thin-wall plastic PVC pipe, material normally used in sanitary systems. Each snag required one 3.08-m piece of pipe, a cap, an insert and a coupling (Fig. 1). We fastened the nest chamber to the coupling and insert with ordinary PVC cement. By leaving the sleeve and the lower margin of the coupling uncemented, we were able to reduce the height of an installed snag temporarily by removing the middle, 0.92-m section of the snag (Fig. 1C). This procedure allowed us to lower the cavity site within mist-netting range to catch adult chickadees once they had begun to feed nestlings. We drilled a 2.8-cm-diameter entrance hole centered 4 cm from the end of the snag. The diameter chosen in other study areas should be as small as possible while still allowing the focal species to enter (K. Otter, pers. comm.). Each snag was painted with gray latex paint. We initially glued patches of fiberglass window screen-

ing to the inside and outside surfaces below the entrance hole to facilitate gripping by adult and young birds, but have found this precaution to be unnecessary (during spring 1994, 48 of 49 nestlings fledged from unscreened cavities).

In Europe, the Willow Tit (*Parus montanus*), a close relative of the Black-capped Chickadee (Gill et al. 1989), is thought to prefer to dig its own cavity, and researchers there routinely fill nest boxes with sawdust for the birds to excavate before nesting (J. Ekman, pers. comm.). To test whether Carolina Chickadees have a similar preference, we created two types of snags, "filled" and "empty." We packed filled snags with red oak (*Q. borealis*) sawdust to just above the upper margin of the entrance hole, while merely covering the cavity floor of empty snags with 1–2 cm of sawdust. We installed both of these types of snags in approximately 0.6-m deep holes dug with a clam-shell post-hole digger or over the base of saplings cut off about 1 m above the ground and trimmed of branches.

During the winter and spring field seasons of 1992–1993 and 1993–1994, we oriented snags vertically in woodlots within a 20-km-long north-south strip-transect straddling the Ashland County portion of the Carolina/Black-capped Chickadee hybrid zone in north-central Ohio (Grubb et al. 1994), and within woodlots supporting a population of Carolina Chickadees 75 km south of the hybrid zone. During December 1992, seventy-six snags were "planted" within the Carolina Chickadee range south of the hybrid zone. The snags were placed in groups of four, and the groups were located far enough apart that we could assume each group would be within the breeding territory of a different pair of chickadees the following spring. Each of the 19 groups of four snags was divided into two pairs. One pair was placed within "shrub habitat," where in addition to the usual tree cover the majority of the area within 2 m of a snag was covered with a shrub layer greater than 0.5 m high. The other pair was placed nearby, but in an area with little or no shrub cover within 2 m of the snags. Because the House Wren (*Troglodytes aedon*), a strong competitor for cavity sites, is most abundant in sites with shrub cover, we wanted to test whether chickadees have a preference for cavity sites removed from shrubs. Finally, each pair, located 2 m apart, consisted of one filled and one empty snag positioned on a random basis. Thus, we arranged for one snag of each quartet to have sawdust and shrubs, one to have sawdust and no shrubs, one to have no sawdust and shrubs, and one to have no sawdust and no shrubs. The distance from the nearest woodlot edge and the compass orientation of that edge were recorded for each snag.

Within the chickadee hybrid zone during the spring of 1994, we addressed the question of whether chickadees have preferred cavity heights for nesting. Details that we are accumulating about the biology of pure and hybrid pairs within the zone are beyond the scope of this paper, but we feel comfortable with the assumption that both species and their hybrids responded similarly to the variation we provided in snag height. We mounted pairs of filled snags on trimmed saplings within known chickadee territories. The snags of each pair were located 2 m apart. In one snag of a pair, the entrance hole was located about 3 m above the ground, while in the other snag, the entrance was only approximately 1.2 m from the ground. The entrances of all snags at both study sites were oriented toward the northeast, away from the prevailing wind.

We employ records from both study sites to answer the question of whether chickadees reproduce successfully in the snags. Most statistical analyses employed two-sided Fisher Exact Tests. The cavity height preferred for nesting was analyzed with a two-sided Binomial Test.

RESULTS

Nest starts were characterized by the chickadees placing a layer of moss over the sawdust surface of the floor of the cavity. Nests were then completed with the addition of a layer of hair, shredded vegetation, and/or feathers over the moss layer. Within the Carolina chickadee site, nest starts were detected in 10 of the 76 (13%) snags. At least one nest start was found in nine (47%) breeding territories. Using our design, we were not able to detect a preference by Carolina Chickadees for nesting in either filled or empty snags (Fisher Exact Test; $P = 0.74$). Nests were started in four (11%) filled snags and in six (16%) empty snags. Nests were begun in three (8%) snags in shrub habitat and in seven (18%) snags in non-shrub habitat, a non-significant difference (Fisher Exact Test; $P = 0.31$).

In the Midwest, woodlots tend to have straight edges oriented in either a north-south or an east-west direction, allowing us to consider the edge nearest each snag to be the north, east, south or west side of a woodlot. Seven of 28 (25%) snags near a south edge had nest starts, while for snags near north, east and west edges, respectively, the figures for nest starts were one of 12 (8%), one of 18 (5%), and one of 14 (7%). Because a valid Chi-square test could not be performed due to small observed values, we grouped results for north, east and west edges and compared the combined result to that for the south edge with a Fisher's Exact Test ($P = 0.04$). This significant result reinforces the conclusion that chickadees were partial to starting a nest near the southern edge of a woodlot.

Within the hybrid zone, 11 pairs of chickadees chose between a taller and shorter snag for nesting. Nine pairs of the birds chose the taller snag for their nest site, whereas two pairs chose the shorter snag. This result is almost significantly different from that expected from chance alone (Binomial Test, $P = 0.06$).

The relatively modest number of records collected from the Carolina Chickadee population and the hybrid zone site indicates that the artificial snags are conducive to successful breeding, although competition from House Wrens can be serious for these snags just as it often is for natural cavities in Ohio (pers. observ.). In the Carolina Chickadee population studied in 1993, eggs were laid in three nests. Of seven eggs laid in one nest, three disappeared (presumably punctured and carried off by House Wrens), one failed to hatch, and three hatched and fledged. Both of the other two nests were taken over by House Wrens some time after the first egg had been laid.

During 1994, 12 chickadee nests in the hybrid zone remained free of wren competition. Detailed consideration of the effects of hybridization on reproductive success is beyond the scope of this report, but the three

pairs located at the north end of our strip transect were judged by plumage and morphology to be pure pairs of Black-capped Chickadees, and those three pairs fledged 100% of their young. The reduced reproductive success of pairs farther south in the transect is believed to be the consequence of hybridization.

In two natural cavity nests in the southern portion of the transect, reproductive success was lower in natural cavities than in some of the artificial snags. One had one of eight eggs hatch with the nestling fledging (Reproductive Success = 0.13) and the other had three of eight eggs hatch with all the nestlings predated (Reproductive Success = 0.00). Therefore, the artificial snags appear to be adequate substrates for successful reproduction.

DISCUSSION

Several relatively clear results have emerged from these initial studies of artificial snags. Chickadees accepted snags as nesting sites and Carolina Chickadees had no preference between filled and empty cavities for nesting. Black-capped Chickadees appear to resemble the closely-related Willow Tit in preferring to excavate a nest site (Smith 1991), so a similar controlled study with *atricapillus* would be quite useful. Carolina chickadees roosted and nested without regard to shrub cover in the vicinity of the snag. Chickadees within a hybrid zone preferred to nest within the taller of two cavities. Finally, the snags appeared conducive to successful reproduction.

Moisture levels appear on occasion to be higher in snags than in natural cavities (K. Otter, pers. comm., pers. observ.), possibly because the walls of the chamber are impermeable to water vapor from exhalations and fecal material. We have not detected any adverse effect of such moisture on chickadee survivorship or reproduction, but such could occur in hotter and/or more humid climates, necessitating a system of cavity ventilation. Incidentally, because the nest-chamber is constructed of materials impermeable to gases, with some minor modifications, the snags could serve as in situ respiration chambers for metabolic studies.

As with other artificial cavities that exclude predators, the generality of demographic data from chickadees nesting in the snags is open to question. By wrapping some snags in burlap or window screening while leaving others as controls, one could assess the effects of mammalian competitors/predators on chickadee demography. It appears the snags have considerable promise in establishing research programs with North American chickadees, and they may prove useful in European studies as well. Although European parids take readily to nest boxes, some birds there do occupy natural cavities (Van Balen 1982, Nilsson 1984). Artificial snags may entice an even larger proportion of such populations away from natural cavities than do nest boxes.

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