WOODPECKER DEPENDENCE ON TREES INFECTED BY FUNGAL HEART ROTS

RICHARD N. CONNER, ORSON K. MILLER, JR., AND CURTIS S. ADKISSON

A considerable expenditure of energy is necessary for woodpeckers to excavate a nest cavity. Factors that would soften the wood in the nest tree prior to excavation would decrease the energy requirements needed to make a suitable nest cavity.

Studies of the Red-cockaded Woodpecker (*Dendrocopos borealis*) by Steirly (1957), Ligon (1970) and Jackson (in press) indicate that this woodpecker selects mainly pines (*Pinus* spp.) that are infected by *Fomes pini* (red heart disease) for nest and roost trees. (Authorities and synonyms for names of fungi are found in Miller and Farr 1975.) Dennis (1969) thought that Common Flickers (*Colaptes auratus*) in Massachusetts were dependent on decayed trees for nest sites. Although he mentions several species of fungi that infected the trees he examined, he unfortunately did not report how the fungi were identified. Kilham (1971) reported that Yellow-bellied Sapsuckers (*Sphyrapicus varius*) in New Hampshire showed a preference to excavate nests in trees infected by *Fomes igniarius*. Jackson (1976) found mushrooms (species unknown) growing inside a nest cavity made by a Red-bellied Woodpecker (*Centurus carolinus*) 4 days after the nestlings had fledged.

The above studies of woodpecker-fungi association apparently used examinations of the fungal fruiting bodies that were on the exteriors of the nest trees or, in the case of *Fomes pini*, red-colored corings with pockets of decay taken from decayed pines as evidence indicating infection.

We tried to culture fungi from the heartwood of woodpecker nest trees in addition to identifying the species that fruited on the exteriors of the trees. Our primary objective was to determine if the Downy (*Dendrocopos pubescens*), Hairy (*D. villosus*), and Pileated (*Dryocopus pileatus*) woodpeckers, and the Common Flicker of the oak—hickory forests of southwestern Virginia, preferred to nest in trees infected by heart rots or whether they excavated nest cavities in trees with firm, undecayed wood. Our secondary objective was to determine what fungi were involved if indeed the decayed trees were preferred.

METHODS

During the springs of 1972, '73, and '74 we searched the upper drainages of Craig and Poverty creeks on Jefferson National Forest in southwest Virginia and the college farm and campus of Virginia Polytechnic Institute and State University for woodpecker nest trees.

Nesting territories of the woodpeckers were located by listening to drumming and vocalizations of the birds. Locations of nest trees were pinpointed by listening for vocalizations and observing movements of the woodpeckers. Chips of wood from the freshly excavated cavities were examined to see if they had been softened by hyphal growth prior to excavation.

After the nesting season we cut down the nest trees and cut out the sections that contained the nest cavity. In addition to the nest cavities we removed sections of the nest tree that appeared to contain the transition zone where recently decayed portions of the tree met undecayed portions. We assumed that the primary wood decay fungus would be found in the newly decayed wood and that isolations from this zone would result in a culture of the primary rot that had infected the tree.

Although we collected 24 nest trees, 10 were so advanced with decay that it was impossible to obtain pure cultures from them. Six Pileated, 4 Downy, 2 Hairy woodpecker, and 2 Common Flicker nest trees were at stages of decay suitable to obtain cultures.

The heartwood from the nest trees was dissected aseptically from 4 to 5 predetermined locations below the nest cavity (Fig. 1) so as to detect, if present, successive invasions of different species of fungi. The chips of wood that were dissected were placed on malt agar. Sixteen to 20 plates were cultured for each nest tree. The actual position from which chips were dissected varied from tree to tree depending on how advanced the fungal infection was. Four additional malt agar plates were inoculated for each nest tree with chips from the zone where decayed wood met firm, undecayed wood.

Isolates were cultured on malt agar in the dark for 8 weeks at 25°C. They were examined every 7 days for growth rate, appearance and color of the mycelium, and odor. At the end of weeks 1, 2, 3, 6, and 8, the cultures were examined microscopically to see if hyphal differentiation had formed special structures as described by Davidson et al. (1942). The agar in each culture was also examined to determine if it were discolored, bleached, or unchanged. At the end of the 6th and 8th week, the cultures were checked for the initiation and development of fruiting bodies.

The presence or absence of extra-cellular oxidases and clamp connections at septa were key factors in the identification. Isolates were cultured on gallic acid agar for 2 weeks and tested with gum guaiac to determine if extra-cellular oxidases were present. Identifications of the fungi were made by comparing observed characteristics with those described by Davidson et al. (1942) and Nobles (1965).

The data obtained from cultural examination of the isolates and cultures of the fungi were sent to Mrs. Frances Lombard at the Center for Forest Mycology Research, Madison, Wisconsin for further cultural examination and confirmation of our identifications. Mating compatibility tests (Buller phenomenon) were conducted to confirm tentative identifications of 10 of the isolates (Buller 1930, 1931, Quintanilha 1937).

In addition to culturing fungi from chips of heartwood, we collected and identified fruiting bodies found on the exterior of the nest trees.

RESULTS AND DISCUSSION

The 14 nest trees examined were infected by a heart rot that had softened the core of the nest tree. The primary rot in most cases was *Spongipellis pachyodon* (syn: = *Irpex mollis*) (Fig. 2). This species is a top rot of hardwood trees and not found in conifers.

Spongipellis pachyodon was the primary rot in 5 of the 6 Pileated Woodpecker nest trees (*Quercus alba, Q. rubra, Q. prinus, Acer saccharum*, and

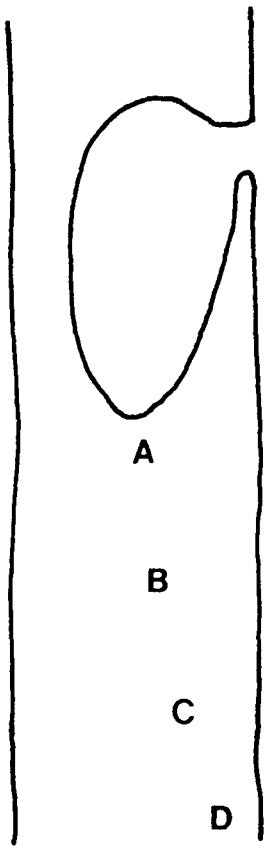

FIG. 1. Relative positions in the nest tree from which chips of wood were taken to culture. Positions were relative depending on how advanced the decay was.

Carya tomentosa) examined. The 6th tree, a table mountain pine (*Pinus pungens*), was primarily infected by a species of fungus that we were unable to identify. Half of the Pileated nest trees were infected by additional Basidiomycetes: *Phellinus spiculosus*, *Corticium alutaceum*, *Polyporus dichrous*, *P. gilvus*, *P. pargamenus*, *P. velutinus*, and *P. abietinus*. We did not detect secondary Basidiomycetes in 3 of the nest trees. All the Pileated nest trees were infected secondarily with imperfect fungi (e.g. *Penicillium* spp. and others) and bacteria.

Spongipellis pachyodon was the primary rot in 2 of 4 Downy Woodpecker nest trees, all of which were hardwoods. The other 2 trees, a mimosa (*Albizzia julibrissin*) and a black haw (*Viburnum prunifolium*) were primarily

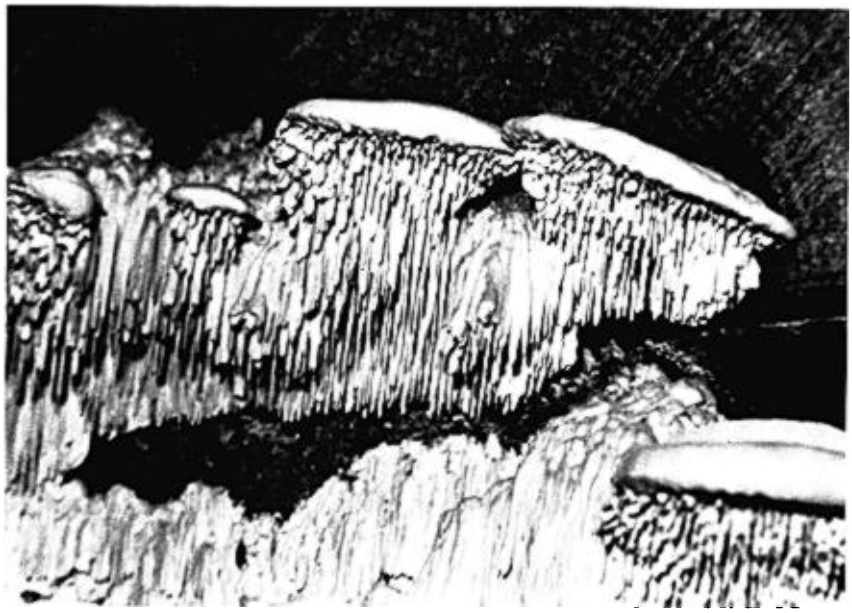

FIG. 2. *Spongipellis pachyodon*, the fungus responsible for the primary rot in 10 of the 12 hardwood nest trees examined.

infected by *Polyporus versicolor* and *Phellinus igniarius* (syn: = *Fomes igniarius*) respectively. Half of the Downy Woodpecker nest trees examined were infected secondarily by Basidiomycetes: *Polyporus versicolor*, *P. pargamenus*, and *P. velutinus*. We were able to detect imperfect fungi in 3 of the 4 Downy Woodpecker nest trees. All the trees were infected by bacteria.

Spongipellis pachyodon was the primary rot in both of the Hairy Woodpecker nest trees (*Quercus coccinea* and *Acer saccharum*) examined. One of the trees was infected secondarily by other Basidiomycetes: *Pleurotus sapidus* and *Stereum complicatum*. Both trees were secondarily infected by imperfect fungi and bacteria.

One Common Flicker nest tree we examined, a chestnut oak (*Quercus prinus*), was infected primarily by *Spongipellis pachyodon*. We were unable to identify the primary rot in the 2nd flicker nest tree which was a table mountain pine. Both Common Flicker nest trees were infected secondarily with other Basidiomycetes (*Stereum hirsutum* and *Poria candidissima*), imperfect fungi, and bacteria.

We superficially examined 7 other Common Flicker nest trees, 6 of which were black locusts (*Robinia pseudoacacia*) and the remaining 1 a yellow birch (*Betula alleghaniensis*). *Phellinus rimosus* was the only fungus ever

observed to fruit on the black locust nest trees and probably was the primary rot in all 6 cases. *Daedalea unicolor* was the rot associated with the yellow birch nest tree.

Decay of the nest trees appeared to be a series of infections commencing with a Basidiomycete; in most cases in our study the fungus was *Spongipellis pachyodon.* Other Basidiomycetes (8 out of 14 cases), imperfect fungi (13 out of 14 cases), and bacteria (all cases) invaded the nest trees following the primary rot.

Although *Spongipellis pachyodon* was the primary rot in 10 of the 12 hardwood nest trees from which isolates were cultured, it had not fruited on the surface of any at the time sections of the tree were collected. Species of fungi that fruited on the exteriors of the nest tree were typically secondary rots (11 of 13 instances). *Spongipellis pachyodon* did fruit on the inside of 2 Pileated Woodpecker nest cavities, but this was after the trees had been cut down and stored indoors under damp conditions for a month. One Red-bellied Woodpecker nest tree that was visually examined after the 1975 nesting season had 3 different places, all near the nest cavity, where *Spongipellis pachyodon* had fruited.

As we examined the nest trees a pattern began to emerge which revealed the initial sequence of invasion of the primary rots in most instances. The fungi appeared to obtain access to the heartwood of the tree via a broken, dead branch. Subsequent hyphal growth proceeded into the core of the main trunk and started a pocket of decay in the heartwood that gradually decayed the core of the tree upward and downward from the initial site of infection. This is probably the reason why many of the nest cavities we examined were immediately below an old stub of a dead, broken branch. Baumgartner (1939) described a similar invasion sequence during the formation of fox squirrel (*Sciurus niger*) dens.

If only a heartwood rot is present, the sapwood of the nest tree remains healthy and firm. This condition appears to be the optimum for a woodpecker nest cavity as it would be difficult for a predator such as a raccoon (*Procyon lotor*) to chew its way into the nest cavity. Kilham (1971) made a similar observation of Yellow-bellied Sapsucker nest trees.

Often following or concurrent with heart rots were sap rots which destroy the living xylem and phloem tissue of the sapwood and thus kill the tree. Sap rots were noticed in most of the nest trees we examined with sometimes several different species of fungi involved. All but 2 of the Pileated Woodpecker nest trees we examined were infected by both a heart rot and a sap rot at the level of the nest cavity. The decay, coupled with the excavation of nest cavities, greatly weakens the nest trees and as a result many were broken off at the topmost cavity in the tree (Conner, et al. 1975).

Some nest trees had been subjected to fungal decay for a very short period of time. These trees appeared completely healthy on the outside. However, when cut down and sectioned a small pocket of rot was discovered. Somehow, probably by sounding the tree with their bills, the woodpeckers had been able to detect the decay and subsequently excavate through several centimeters of healthy oak before hitting the decayed pocket out of which the nest cavity was chiseled.

We examined freshly excavated chips of wood from 78 other nest trees of the 4 species of woodpeckers. All had been softened by fungal decay. We saw on several occasions for each woodpecker species, aborted nest excavation attempts after only 2–5 cm of penetration. In all instances, the woodpeckers subsequently excavated a cavity either in another tree or in a different place on the same tree. These observations may indicate that woodpeckers occasionally err in detecting suitably rotted nest sites.

There are many species of fungi that cause heart rots in southeastern hardwoods. *Spongipellis pachyodon* is considered an infrequent species in our geographical area, yet was found in our isolates as the primary rot in more than 80% of the hardwood trees we examined. This imbalanced association suggests several possible explanations. The woodpeckers may be preferentially selecting trees infected by *Spongipellis pachyodon.* Another explanation is perhaps more feasible. Since *Spongipellis pachyodon* is a top rot that fruits infrequently, its detection by forest pathologists would be very difficult. Other species of heart rots that fruit frequently and infect portions of the trees closer to the ground would be easier to detect and thus might seem to occur at a greater frequency than *Spongipellis pachyodon.*

It is possible that the presence of a particular fungal flora in woodpecker nest trees may impart a hitherto undetermined benefit to the well being of the developing fledgling. Investigations are needed to determine if respiration of the fungal flora produces enough heat to decrease the incubation and brooding requirements of the adult woodpeckers.

SUMMARY

Four species of woodpeckers used trees with heartwood softened by fungal heart rots prior to cavity excavation. The woodpeckers were apparently able to detect the presence of the heart rots and select suitably infected trees for nest excavations, thus reducing the energy expenditure necessary to excavate nest cavities. *Spongipellis pachyodon* was the primary rot in most of the trees we examined. Nest trees were usually infected secondarily by other Basidiomycetes, imperfect fungi, and bacteria.

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DEPT. OF BIOLOGY, VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIV., BLACKSBURG 24061. ACCEPTED 30 MAY 1976.