The N1IR Tree Antenna

Yes, this is *the April issue...but this is a* real *antenna, not a joke!*

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This "biological antenna" may be the most peculiar antenna you'll ever hear of . . . and it works!

In the last few years, I have been designing and building a variety of new and exotic antennas; specifically in the field of fractal antennas, which are built around those exotic shapes showing up just about everywhere. The new antenna described here was inspired by some theoretical (model-based) work, in which mathematical "fractal trees" were found to be high gain antennas. Also, I was aware that real trees had been shown to be VLF resonators about 15 years ago. In *QST* I'd seen old reports of trees poorly resonating at 40m when tuner-fed. Would they work at *any* communications frequencies? I decided to put my scientific skepticism aside and let my curiosity take over.

Fact: Real live trees *are* antennas. But before you exchange your antenna farm for a tree farm, keep in mind that real trees are mediocre-to-good antennas which only seem to work at VHF and UHF. Here's how to "build" one.

"Real live trees* are *antennas."

First, find a tree 15 to 20 feet tall. Bring your coax to the ground at the foot of the tree and firmly hammer a 1-foot ground rod into the soil about 2 inches from the trunk. Attach the braid to the ground rod. The rod should only be visible an inch or two above the soil. Next, hammer a 1-inch nail into the trunk, about 2-4 inches up and close to the ground rod. Connect the center conductor onto the nail. If you wish, you may place a ferrite collar at the feed to assure that it's your tree that's radiating. See Photos A and B, which show my connection to a 20-foot oak tree, and the tree antenna itself.

Photo A. *The author's connection to a 20-foot oak tree.*

Now go and operate. You will find that the "tree antenna" resonates broadly (less than 2:1 SWR) from about 120-175 MHz for a 50 ohm feed. It is mostly resistive, and not reactive, near 2m. You'll have a 2m antenna—without the antenna! The tree antenna seems to perform roughly 2 dB better than a 1/4-wave duckie (based on a direct comparison). Don't expect it to perform like a high ground plane, though—it will easily be 8-12 dB below even a modest, raised commercial ground plane vertical antenna. A true gain antenna it's not—but it's nature's free gift to the VHFer. Here, near Boston, my tree antenna is on a hill and I get into the Derry, NH, repeater (K1MNS) and the Carlisle, MA, repeater (W1FC) full-quieting with 1 watt. That's 40-45 miles away. Same story with DX packet on K1EA, which easily connects from 35 miles with a watt. My results may not be typical, though, because of my elevation. If there's a repeater 10-15 miles away, a tree antenna should be adequate in most locations.

To double-check my results I had to establish that it was the *tree* radiating, and not the coax (all of which was on the ground). I loaded the ground only; no dice. Then I disconnected the hot conductor from the tree and watched the signal go away. I fed the tree with different lengths of coax—from 1 inch to 100 feet—and noted the (minor) SWR changes. The MFJ 259 SWR analyzer

was handy for this. I minimized the length of unshielded coax at the feed to a few inches or less; a very high SWR would show *this* to be the radiator. Finally, I placed a ferrite collar on the coax at the tree to stop coaxial radiation, and then used an IC Engineering field strength meter on a pole to confirm that the radiation was emerging from the tree and not the ground. Maximum near-field readings came from the lower trunk and upper branches.

The tree seems to resonate by virtue of its height. This might also be expressed by its trunk diameter, since a thick trunk goes with a high tree. I found, roughly, that the resonant frequency goes as the formula:

$$f = 150\ (D)^{-0.20}\ \text{MHz}\ [1]$$

for D, the trunk diameter, in inches. The resonance is of very low Q. I measured a Q of about 3 for several different trees (mostly maples and oaks) . The lowest resonance I attained was about 100 MHz for a 1-1/2 foot (trunk diameter) oak tree. Keep in mind that I had no equipment capable of checking VLF resonances, just as I suspect that the previous investigations had not checked out VHF possibilities. The tree worked poorly when fed by a tuner on 40m and 20m; it was basically a dummy load at HF.

cart him off to the funny farm. Imagine the "no antenna" controversy in your town erupting over trees. Time to pull them all down—or defer to the intent of PRB-1! Seriously, though, it is a good emergency antenna, and may be useful for RC-controlled lawn and patio electronics, among other things. And will there be a tree-based repeater soon?

A few cautions: First, *never* use high power on the tree; it could result in a fire. Next, be aware that rain and snow will undoubtedly (temporarily) short out the antenna, or at least change the SWR. Ground conditions also change the resonant frequency, but the resonance is so broad that you will experience only minor 50Ω SWR changes (mine was 1.3:1 at 2M) after it rains.

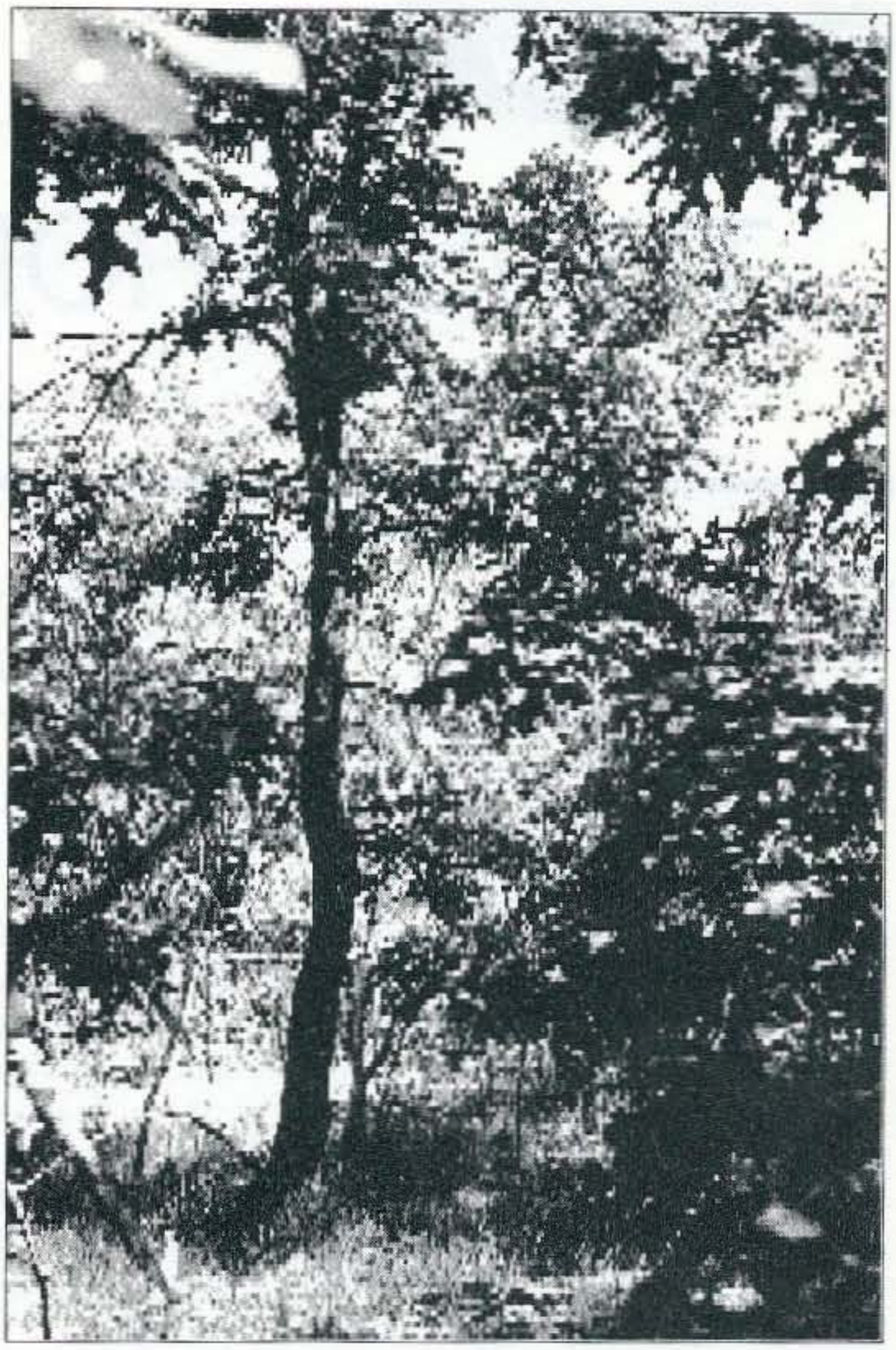

***Photo B.** The tree antenna itself.*

"The tree antenna seems to perform roughly 2 dB better than a 1/4-wave duckie."

To explain the tree radiator, it is tempting to use fractal theory. Such a broad resonance radiator could easily be explained by a "multifractal spectrum," indicating that the real tree is not just one fractal pattern, but a variety of patterns akin to one another (clouds are a great example of something with a multifractal spectrum). It is not known to what degree the roots function as "radials." Further work needs to be done to show how the fractality of real trees affects their characteristics as antennas, if at all. Unlike the fractal tree antenna, the real tree antenna is capacitively loading the feed, and is not high in gain.

Why use a tree antenna? Aside from the novelty, a tree antenna is the ultimate stealth antenna. If your neighbor complains about a radiating tree, it's time to

Also, if you *depend* on your VHF link, try a backup antenna (or make the tree your backup). Finally, I am not suggesting a new scientific field where you: "plug in a petunia," or "radiate the radishes." Anything that's water-based will radiate (or at least load)—usually poorly. Because they are tall, stationary, grounded, and don't complain, trees make the best "biological antennas."

On a practical note: *Trees are resonant structures*. Therefore, at VHF and UHF, it's best to get as far *above* and away from them as possible. Your backyard forest is not transparent to RF.

Does being an antenna do anything for the tree? Probably not. Note, however, that trees do *not* resonate well at LF, HF and MF. It is at these frequencies that much of the energy from lightning is discharged. Could being a poor low-frequency radiator help a tree survive lightning strikes? We will never know—unless trees start doing something bizarre, like talking back. And if they do....I'm not listening! 73