Robert Nicholson

Lecturer in Biological Sciences

SMITH COLLEGE

Biography

Robert Nicholson's recent research has involved field collection of primitive conifers for screening for anticancer compounds, genetic analysis of large area clonal stands of the rare *Gaylussacia brachycera* (Box Huckleberry), pigment analysis and pollination biology of the black flowered *Lisianthius nigrescens* (Gentianaceae) of Mexico, and highspeed video capture and analysis of the rapid pollen release mechanism of the New World orchid *Catasetum*.

NATURAL HISTORY DECEMBER 1990

COVER: *Waiting to ambush prey, a big-bellied seahorse of New Zealand—about eight inches long from the tip of her tail to her coronet—anchors herself against the ocean currents. Story on page 34. Photograph by David Doubilet.*

Chasing Ghosts

The steep ravines along Florida's Apalachicola River hide the last survivors of a dying tree species

by Rob Nicholson

In the year 1875, the prominent Harvard botanist Asa Gray left the cloistered air of the Harvard herbarium for a trip to the Deep South. His destination was the Florida panhandle and a unique refugium of botanical rarities known as the Apalachicola Bluffs. Within the sharp, dissecting ravines of this Florida high ground grew a humid forest and an odd mix of subtropical and temperate elements; the refugium was also the only known home of the rare conifer *Torreya taxifolia,* or stinking cedar. Based in the "dead and dilapidated, but still charming" town of Apalachicola, the prim Gray endured rough accommodations. A hired boat brought him into the backwater of the twining Apalachicola River; he traveled among fallow cotton plantations and through thick, biting forests, coming ashore alongside the bluffs to penetrate the riverside thicket of bald cypress, palmetto, bamboo, and tupelo. Pushing through the spider-laden undergrowth and showing a New Englander's fear of 'gator grunts, he was taken to the tree he had traveled so far to study. It was a beautiful, shaggy pyramid, some fifty feet high and cloaked with glossy evergreen needles. It looked vaguely like its cousins, the yews, but its needles ended in sharp, piercing tips, and rather than bearing the fleshy red fruits of yew, they held clusters of green, olive-sized, leathery drupes. Its foliage, when crushed, gave off a sharp, resinous odor, from which its common name, stinking cedar, was derived.

Gray noted the restricted range of the tree and its highly specific habitat requirements and, like any Harvard professor worth his chair, hazarded a prediction: "So this species may be expected to endure, unless these bluffs should be wantonly deforested—against which their distance from the river and the steepness of the ground offer some protection. But any species of a very restricted range may be said to hold its existence by a precarious tenure."

Little more than 100 years later, the stinking cedar, member of a genus whose history goes back 160 million years, is on the brink of extinction. In 1963, Robert Godfrey and Herman Kurz, botanists at Florida State University, alerted the botanical community to a rapid, unexpected decline in the number of adult trees. They surmised that a "fungal disease of the stems" was the apparent cause and reported that the species' extinction was imminent. Since that time, pathologists, seeking to isolate a culprit fungus, have succeeded in identifying a few species of fungus from infected plants. These pathogens, however, are commonplace native species, so speculation now presumes a combination of factors; perhaps some environmental fluctuation or collapse weakened the trees to a point where they were readily infected by native fungi. Some botanists point to a drought in the 1950s as a period when the trees were severely weakened. But given the tree's long history in the region, it seems unlikely that this was the most aberrant shift in climate the stinking cedar has had to face.

The genus *Torreya* has had one of the longest periods of existence of any woody plant species on earth. The oldest remains of *Torreya* were found in Europe and date back more than 160 million years; in the New World, North Carolina has yielded fossils more than 100 million years old. There are seven known living species: *T. nucifera* in Japan and Korea; *T. grandis, T. jackii, T. fargesii,* and *T. yunnanenis* in China; *T. californica* in California; and *T. taxifolia,* the stinking cedar, growing in a limited area of Florida and just nipping across the border into Georgia. What remains of *T. taxifolia* are just a few hundred juvenile trees, suckers, and saplings, few more than eight feet high, few more than twenty-five years old. These trees probably resulted from the last wave of sexual reproduction, germinating from a final crop of seed three decades ago.

Despite the efforts of plant pathologists and ecologists to pinpoint the cause of the species' rapid decline, no one factor has yet been cast as the villain. The suspected pathogen operates like the chestnut blight of the eastern United States in the first half of this century; it permits growth in saplings or root sprouts, but these succumb soon after they make the transition to sexual maturity. As if to complete a conspiracy, deer, keen on removing the felty bloom from their antlers, use the bark of the young saplings as favorite rubbing posts. They knock down or irreparably damage many of the struggling survivors, helping to accelerate a downward spiral of fewer and punier trees. Wild trees rarely bear fruit, and only four are known to have reached sexual maturity and can be typed as pollen bearing or seed bearing.

All the unknowns confound any recovery plan. Is *Torreya* an early victim of global warming and a precursor of a new wave of inexplicable extinctions? Has local land use destroyed this *Torreya* habitat? Is there any point in trying to fortify existing populations by replanting if a virulent pathogen lurks unchecked? Will propagations of cuttings from existing wild trees carry a new pathogen wherever the new trees are distributed? Or, frozen by doubt, will plant scientists do nothing while the unique species slips away, tree by tree?

Despite gaps in our understanding of the species' ecology, a recovery plan has begun, supported by the Center for Plant Conservation and the Florida Nongame Program. Plant pathologists, ecologists, and horticulturists have teamed up to salvage as much as possible of the population's germ plasm. This is to be accomplished by better understanding the species' growth tolerances and disease susceptibility, by developing a profile of how much variation there is between individual plants, and by propagating as many disease-free cuttings as possible to represent that diversity in managed populations grown away from the plant's native range.

Meanwhile, hypotheses as to why this multimillion-year resident is going extinct posit a human-induced change in the environment, a new or more virulent fungal strain, drought, or a combination of such factors.

Just prior to the decline of *Torreya,* part of the uplands above the Apalachicola ravines were clear cut and planted with slash pine, a species favored by the paper pulp industry. Clearing the area may have changed the water level of the ravines or increased the ambient temperature as heat radiated off the unshaded soil, weakening the trees to the point that they became especially susceptible to the native fungi. The planted seedlings of slash pine may have also started the downturn by bringing in a new, foreign pathogen.

One intriguing theory has been put forward by Mark Schwartz, a biologist with the Florida Nature Conservancy, who spent four years studying the ravines. Ground fires resulting from lightning strikes have been a constant feature of the region's longleaf pine forests through the millennia. Smoke drifting from these upland blazes settled in the ravines and may have acted as a natural fungicide, keeping the load of fungal spores to a tolerable level. When humans, over the last hundred years, began suppressing local forest fires, the spore load may have reached a deadly critical mass, a population bomb of disease.

In June 1989, I joined Mark Schwartz and we surveyed as many ravine systems as possible, carefully mapping and labeling the plants growing there. The main ravines often have side branches, which also have side branches, so navigating in and out can be tricky and relocating plants even trickier. With support from the Florida Nongame Program, Mark had designed a genetic study of the remaining populations of *Torreya,* to examine differences between populations of the major ravines and, in a few cases, closely neighboring but ecologically distinct side branches. In addition to those in the ravines east of the Apalachicola River, we were able to locate the only known stand west of the river, some five trees on the southern tip of Dog Pond.

When we returned in the fall, we collected small cuttings, tissue samples, and soil samples for genetic, propagation, and pathological studies. Alarmingly, in just a few months, a number of our mapped trees had been lost—to deer rubbing, disease, and even falling limbs from the upper canopy. The species was going extinct before our eyes and will probably not last another generation.

The technique for making genetic profiles is isoenzyme electrophoresis. Using ten to twenty needles from a sampled tree, an extract is made and applied to the edge of a flat, thin slab of starch gel. For several hours an electric current is passed from one end of the gel to the other. Protein molecules within the extract move varying distances across the gel in response to the current. Once stained for a particular enzyme system, the molecules show a pattern of dark bands that, when compared, can give a rough picture of genetic variation within a population sample. This can give the project a way to determine which trees might contain atypical genes and which trees to emphasize when propagating root cuttings in preserves.

The Apalachicola Bluffs and the ravines that dissect them are at the cusp of the deciduous woodlands and the lush subtropical jungle. It is an undecided forest, its luxuriant ecotone having been shaped by the forces of glaciation during the Pleistocene era. As a New Englander used to deciduous woods, I was unsettled by seeing beech, maple, and hickory mixed with bold fan-leafed palmettos, spiky yuccas, and huge, evergreen magnolias. Vines are constant, whether huge lianas of grape or the ubiquitous cloth-shredding cat brier (why can't this plant go extinct?). You don't stroll through this wood, you battle for territory.

To travel the bluff tops down the steep slopes to the creek beds, 100 to 200 feet below, is to read a primer in zonal plant ecology. Species are stratified by drought tolerance and light demands. Those on the tops of the bluffs are adapted to full sun and dry conditions. Endangered gopher tortoises burrow amid opuntia cactus, longleaf pine, yuccas, and bushes of sparkleberry. At the base of the ravines can be found the rare Florida azalea, native bamboo, and Sabal palmetto amid a thick tangle of Florida star anise that rivals the tangled rhododendron "hells" of Virginia and Tennessee.

The steep pitch between these two zones includes a number of endemic plants: croomia, Ashe's magnolia, Florida yew, pyramid magnolia, and *Torreya,* as well as species known throughout the eastern seaboard, such as American holly, American beech, tulip tree, and leatherleaf. The southern magnolia, known to me as an ornamental tree of glossy green, rubber-tree-like leaves, festooned with outlandishly large, white flowers, here grew as 100-foot forest giants, with a first branch higher than a man could throw a rope and with crowns so dense they blotted out the sun.

The Florida yew, like the *Torreya,* belongs to the Taxaceae family. It is also a rare endemic, whose range is actually smaller than, and within, that of *Torreya.* Although occupying much the same habitat, the yew has not been affected by whatever is affecting its larger relative. The ravines are not identical, however. Variations in grade, soils, aspect, and moisture create subtly different habitats, some of which *Torreya* can tolerate. It dominates nowhere, and past references indicate it never did. It is an occasional, midcanopy, midslope tree found on sandy limestone soils. In general *Torreya* prefers good drainage to flat, constantly wet soil; and while it is almost always found in filtered, dense shade, I have seen cultivated *Torreya* grow perfectly well in full sun. In its native environment, the stinking cedar may be better able to compete on the shaded slopes than in sunnier areas.

My days in the ravines were a time of chasing ghosts, Asa Gray's Yankee accent whispering among the palmetto and pine. The *Torreya* themselves had to be imagined. Rather than seeing the spindly, stunted remnants, the mind had to put in place beautiful, shaggy, fifty-foot-high green pyramids. The trunks of *Torreya* have a remarkable capacity to resist rot. After thirty years, many can still be found intact on the forest floor, marking where the victim fell—a botanical version of the detective's chalk outline of a fallen body. *Film vert* instead of *film noir.* Seeing the length and girth of these trunks was stunning after days of finding the meager stands of survivors. The largest seen was more than sixty feet long, and a few were more than eighteen inches in diameter. Gray reported trees more than four feet in circumference.

Diseased needles, scrapings from the surface of cankers, and soil samples were bagged and will give plant pathologists another chance to try to isolate a pathogen. Each tree sampled was given a metal label with a code number. More than 2,500 cuttings were collected from 166 trees and were treated with a variety of hormones to promote rooting. These were brought to Harvard's Arnold Arboretum, where 2,100 were successfully rooted and potted. The accession number of the sampled trees follows each of these clones (and any subsequent propagations) with the particulars as to the plant's original location in the wild. Therefore, in the distant future, ravines might be replanted with the same genetic material that once grew there.

Cuttings taken from the wild five years ago are growing well and so far show no signs of disease. Although the surfaces of the cuttings were sterilized, we are unsure if pathogens lurk within. Still, we can strive to produce clean plants by experimenting with these cuttings in quarantine. One possibility we are examining is micropropagation, growing small cuttings or buds in test tubes on a sterile nutrient medium. Unfortunately, conifers are difficult to propagate in this fashion.

To talk with lifelong residents of the town of Chattahoochee about the local *Torreya* species draws out wistful remembrances of boyhood play among the lost evergreens. Angus Gholson, the preeminent naturalist of the area, told me of sledding down through a grove of the trees on a fresh fall of dry leaves while sitting astride a sled made of barrel staves. Brady Turnage, whose brother, horticulturist Burl Turnage, labored long to unlock the secrets of propagating *T. taxifolia,* told me of hunting turkeys in a grove of the trees near the slope of Chattahoochee. To these aging gentlemen, another part of the Old South seemed as irretrievably lost as courtly manners and virgin forests.

While the few remaining saplings may outlast the blight, not many people who have seen the trees would bet their houses on it. More likely, clusters of trees, propagated from specific ravines, will be grown in botanical gardens, universities, preserves, and state parks. This Florida native, as evidenced by the few healthy trees in cultivation, seems to thrive on the southern slopes of the Appalachian Mountains and is more cold tolerant than its present range would suggest. Possibly an Apalachicola refugium can be re-created, an artificial *Torreya* forest where pollen can float, genes mingle, and the evolution of the past hundred million years can continue, even if it is in a pitifully discounted format.

Rob Nicholson studies rare and endangered plants at Harvard University's Arnold Arboretum.