THE KNEES OF THE BALD CYPRESS: A NEW THEORY OF THEIR FUNCTION.

To the Editor of GARDEN AND FOREST:

Sir.—From time to time, during and since my first visit to our southern tier of states in 1876, I have examined, sketched and photographed the roots of the Deciduous Cypress—the *Taxodium distichum* of Richard. I was attracted to the tree because of the singular beauty of its form and foliage and by the unusual boldness with which it raises its great, gray, smooth column, sometimes over a hundred feet, perpendicularly, above and upon what an engineer would pronounce a most dangerous foundation—loose submerged sand, the saturated morass or the soft alluvium of low river margins. But notwithstanding this seeming insecurity, I have never found a healthy Cypress that had fallen before the fierce hurricanes that sweep through the southern forest-lands.

The surprising and characteristic temerity of the tree is accompanied by another striking peculiarity—it almost invariably, in soft soils, throws upward from the upper surface of its roots conspicuous protuberances that are known as "Cypress knees."

These seemingly abnormal growths have attracted much attention, and for more than half a century have furnished an enigma to the solution of which scientific travelers have addressed themselves. . . .

In 1887 I had the good fortune to find a number of Cypress-trees under such unusual conditions that their aforetime subterranean anatomy could be studied without obstruction, and I reached a conclusion respecting the use to the tree of the protuberances . . . Some recent publications on the subject, by widely and favorably known authors, have, however, ascribed to the Cypress-knees the sole function of aërating the sap of the parent tree, and this idea bids fair to become embedded in botanical literature. . . .

Stretches of the shore of Lake Monroe, in central Florida, are closely set with large Cypress-trees. They grow in various kinds of bottom—clay, mud and sand. Those of which I shall here speak stood in sand so loose that when the level of the water was lowered the waves readily washed it away and carried it into the depths of the lake. Some vertical feet of the root-system was thus finely exposed. After several days spent in examining a score or more large trees that had been thus denuded I became convinced that the most important function of the Cypress knee is to stiffen and strengthen the root, in order that a great tree may anchor itself safely in a yielding material. . . .

The accompanying picture is from a photograph that I made in 1887 of the lower portion of a tree that rises some seventy feet above the shore line of Lake Monroe. The original surface of the sand was near the level of the higher roots. The picture shows the manner in which this peculiar species throws out horizontal roots from its conical (usually hollow) buttressed base. At different distances from this conical base these horizontal roots project strong branches more or less perpendicularly into the earth. Where such perpendicular "flukes" branch from the main horizontal "shank," it will be seen, there is formed a large knob, which is the "knee" under discussion. This knee, when fully developed, is generally hollow, comparatively soft, gnarled, and very difficult to rupture, so that it has the quality of a spring that becomes more rigid as it is extended or compressed out of its normal shape. When in a hurricane the great tree rocks back and forth

Denuded roots of the Bald Cypress, showing knees and underground structure.

on its base, and with its immense leverage pulls upon this odd shaped wooden anchor instead of straightening out in the soft material as an ordinary root might, thus allowing the tree to lean over and add its weight to the destructive force of the storm, it grips the sand as the bower-anchor would do, and resists every motion. The elasticity at the point of junction allows one after another of the perpendicular flukes attached to the same shank to come into effective action, so that before being drawn from the sand or ruptured the combined flukes present an enormous resistance. . . .

Finally, I may perhaps be permitted to add an observation regarding the roots of other trees that trench upon the same soils affected by the Cypress and often take advantage of the anchors it sets so boldly in treacherous bottoms. These trees project their cable-like, flexible roots in every direction horizontally, interlacing continually until a fabric is woven on the surface of the soft earth like the tangled web of a gigantic basket. . . . Such communities of trees, provided with ordinary roots, advance against and overcome enemies where singly they would perish in the conflict. The cyclone, the loose sand, the morass—these are the enemies they contend with, as it were, in unbroken phalanx, shoulder to shoulder, their shields locked, their spears bristling against the foe; but the graceful plumed Cypress, the knight-errant of the sylvan host, bearing with him his trusty anchor—the emblem of Hope—goes forth alone and defiant, afar from his fellows, scorning the methods of his vassals, and planting himself boldly amid a waste of waters, where no other tree dare venture, stands, age after age, erect, isolated, but ever ready to do battle with the elements. Twenty centuries of driving rain and snow and fierce hurricane beat upon his towering form, and yet he stands there, the stern, gray and solitary sentinel of the morass, clinging to the quaking earth with the grasp of Hercules, to whom men were building temples when his wardenship began.

New York, Jan. 2d. *Robert H. Lamborn*
[*Garden and Forest* 3 (1890): 21–22]

THE KNEES OF THE BALD CYPRESS.

To the Editor of GARDEN AND FOREST:

Sir.—I have read the interesting essay of Dr. Lamborn in your issue for January 8th with great pleasure. My own observations on the knees of the Cypress do not seem to me reconcilable with Dr. Lamborn's hypothesis. The objections which they raise to it are as follows:

1st. The trees on the sandy uplands need the assumed support quite as much, if not more, than those which grow on the neighboring loam—often clayey—of the inundated bottoms, yet these upland forms always lack the excrescences.

2d. While a slight upward growing protuberance would doubtless strengthen the root, the tall column exhibited by many knees would have no value in this regard.

3d. The summits of the knees normally attain a height which brings them above the level of the water in the growing season; when they cannot attain this elevation the tree fails to develop. When, by the subsidence of the land at an earthquake, or the artificial flooding of the area by dams, the crests of the knees are brought under permanent water, the condition is fatal to the plant.

4th. The fact that the Cypress-knees serve as respiratory organs is made the more probable by the existence of sharp upward flexures of the roots of the Tupelo (see "Effect of permanent moisture on certain forest trees" in *Science* (xiii., 176; March, 1889). These flexures, as there shown, are horseshoe-shaped curves of the whole root, which, like the Cypress-knees, rise above the level of permanent water. On the Tupelo these structures are clearly of no advantage as anchors. Dr. Wilson and others have shown that similar structures exist in many plants.

I was aware that roots extended downward from the base of the Cypress-knees, but it seemed to me that the position of these roots was to be attributed to disturbance in the circulation and growth, brought about by the development of the knees rather than that the knees gave rise to the vertical roots.

Although I cannot at present agree with Dr. Lamborn in his main view, his paper seems to me a very important contribution to a discussion which promises to throw much light on the laws of plant development.

Harvard University. *N. S. Shaler*
[*Garden and Forest* 3 (1890): 57

Editor's note: It appears that both correspondents were incorrect. C. A. Brown and G. N. Montz wrote in *Baldcypress: The Tree Unique, The Wood Eternal* (1986): "The concept that baldcypress knees are pneumatophores has not been accepted experimentally, but the knees have been shown to conduct respiration. The height of knees cannot, in all cases, be correlated to the average high water levels. Only knees attached to low, conical trees may be used to determine the average height of floodwaters in a given swamp. Knees, when present, may aid in strengthening of the basal support, but they apparently do not function as anchoring devices for the trees since those without knees are wind-resistant. Knee formation is considered to be a response to the aero-hydroperiod. Based upon all studies to date, we conclude that storage of starch (which can be converted back into glucose as needed) is the major function of baldcypress knees."]

THE TUPELO TREE.

THE forests of eastern America contain few trees more interesting to the botanist or of greater ornamental value than the Tupelo, Pepperidge, Sour Gum or Water Gum, as one of the American representatives of the small genus Nyssa is popularly called in different parts of the country. This genus was so named by Linnæus for a water nymph, because the species known to him, inhabitants of our far southern states, grow usually in shallow ponds or deep swamps overflowed for a considerable part of each year. Its nearest American relatives are the Cornels [dogwoods], from which Nyssa differs principally in its five instead of four-parted flowers, which are rarely perfect, but produce their male and female organs separately, while the flowers of the Cornels are perfect, and, in its alternate leaves, the leaves of our Cornels being opposite except in the case of a single species.

The distribution of the genus is exceptional and interesting. Three species, or four, according to the opinion of some excellent observers, inhabit different parts of eastern North America from Maine to Texas. . . . This is not the place, and it is not our intention, to discuss at this time the limits of the different American species, which have puzzled botanists ever since they have known them, the confusion beginning with Linnæus himself, who included two very distinct species under his original description. It is our purpose merely to call attention to one of the species still little known or appreciated by planters as an ornamental tree. This is the Nyssa which is generally distributed through all the eastern portions of the United States south of the southern part of the state of Maine and central Michigan. *Nyssa aquatica* appears to be the correct botanical name for this tree, although it is only in the extreme south that it grows in water. [The specific *N. aquatica* is now used only for that southern population and *N. sylvatica* for the more northerly and abundant populations.] Near the coast of the northern states it always grows by the borders of swamps in low, moist ground; and in the interior, especially on the lower slopes of the high Allegheny Mountains, where it attains its greatest size, it is found at considerable distances from the water-courses and associated with the Oaks, Magnolias, Hemlocks, Hickories and Ashes which form the principal part of the forest-growth. Here the Tupelo grows sometimes to a height of considerably more than a hundred feet, with a tall, stout trunk three or four feet in diameter, and short slender branches, contracted in their development by its neighbors in the forest. Near the coast it is always a much smaller tree, especially in the southern states, and it is rare to find it more than fifty feet high except in the mountain forests or in those of the lower Ohio valley—a region of exceptional and extraordinary tree-growth. . . .

The Tupelo was introduced into England in 1808 by John Lyon, an English plant-collector who traveled widely in North America early in the century. It was doubtless sent earlier to France, as it is hardly possible that Michaux could have