A PRELIMINARY KEY TO SOME FOREST TREE ROOTS

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During the past several years the writer has had occasion to dig up and examine large numbers of tree roots. It has been necessary also to know what kind of roots were being examined in each case. This sometimes has involved hours of hard work, for in the woods where the roots of numerous trees are intermingled it is sometimes necessary to trace a root for a considerable distance through the soil in order to determine to which particular tree it belongs. It early became apparent, however, that there are characteristic differences by means of which some kinds of roots may be distinguished from certain other kinds. The recognition of this fact led to an attempt to learn the distinguishing characteristics of the roots of the genera that were most frequently dealt with, and finally to utilize these characteristics in the construction of a workable key.

It is obvious that a key based on the characters of a single member of the plant cannot be so completely satisfactory as one based on the characters of the plant as a whole. This would be true whether we were dealing with roots, stems or leaves. Yet either stems or leaves might be classified into groups on the basis of readily recognized characters and such classifications might prove very useful in case no other members of the plants were available. Likewise it is true of roots that while it would be impossible to identify many plants by the roots alone yet having learned root characteristics it is easy, for instance, to tell that oak roots are not maple roots.

The following key and descriptions are offered, then, not as a finished product nor in the hope that it will enable workers to recognize readily all of the roots considered at all times and under all conditions. They are offered rather as a beginning of an effort to differentiate the roots of woody plants and in the hope that since the scheme has proven of use to the writer it may also be of some service to others. It is entirely possible if not probable that in some instances I have failed to fix upon the most dependable

character and that further study will reveal other characters that may be used to greater advantage. It should be said too that the characters as used apply primarily to the superficial layers of soil to a depth of about one foot since the mycorrhizal characters would not apply, as a rule, to the deeper roots.

The characters of which most use is made are the presence or absence of mycorrhizal structures, the colors of the root bark and the relative size of the ultimate or smallest branches. The appearances of the various types of mycorrhizas has been described in a previous paper.[1] Although living ectotrophic mycorrhizas are usually absent from all trees in late spring and early summer, yet in case of trees which habitually produce mycorrhizas there is nearly always abundant evidence of them in the dead coral-clusters of mycorrhizal roots. The color of the bark that is taken is the color just within the surface after the dirt and the outermost surface layer have been scraped away by means of a blunt instrument such as the edge of a garden trowel. The size of the smallest branches of the root systems of various plants varies greatly in different species and is reasonably constant. The smallest roots of some trees are very coarse, those of others very fine and those of a third group are intermediate in this respect. An intermediate size of roots does not make a good key character but it has been possible in the following brief key to use this character only in those cases in which the roots are either conspicuously coarse or fine.

Other characters that are used in the key are the colors of ectotrophic mycorrhizas, the odor of the roots, the presence or absence of endotrophic mycorrhizal "beads" and the presence or absence of stiff brown root hairs. The first two of these characters are obvious without any explanation while the endotrophic mycorrhizal beads and the thick-walled root hairs have been described in earlier papers.[2]

1. McDougall, W. B.—On the Mycorrhizas of Forest Trees. Am. Jour. Bot. 1:51-74. 1914.

2. McDougall, W. B.—loc. cit. and Thick-walled root hairs of Gleditsia and related genera. Amer. Jour. Bot. 8:171-175. 1921.

KEY

A—Ectotrophic mycorrhizas abundant ..... B.
AA—Ectotrophic mycorrhizas infrequent or lacking..... D.
B—Bark red .....Carya ovata ..... 1.
BB—Bark yellow..... Carpinus caroliniana ..... 2.
BB—Bark brown ..... C.
C—Mycorrhizas usually white—Quercus rubra and Q. muhlenbergii..... 3.
CC—Mycorrhizas usually brown—Tilia americana ..... 4.
D—Ectotrophic mycorrhizas present ..... E.
DD—Ectotrophic mycorrhizas lacking ..... G.
E—Bark brown.....Ulmus americana ..... 5.
EE—Bark whitish.....Carya cordiformis ..... 6.
EEE—Bark yellowish ..... F.
F—Ultimate branches fine—Celtis occidentalis ..... 7.
FF—Ultimate branches coarse—Aesculus glabra ..... 8.
G—Endotrophic mycorrhizal beads present .....Acer—9.
GG—Endotrophic mycorrhizal beads lacking ..... H.
H—Stiff brown root hairs present ..... I.
HH—Stiff brown root hairs lacking ..... K.
I—Ultimate branches fine—Cercis canadensis ..... 10.
II—Ultimate branches coarse ..... J.
J—Root hairs numerous—Gleditsia triacanthos ..... 11.
JJ—Root hairs not numerous—Gymnocladus dioica..... 12.
K—Roots with odor of walnuts—Juglans ..... 13.
KK—Roots without odor of walnuts ..... L.
L—Ultimate branches fine—Morus alba ..... 14.
LL—Ultimate branches coarse ..... M.
M—Bark black—Asimina triloba ..... 15.
MM—Bark brown—Benzoin melissaefolium ..... 16.
MMM—Bark whitish ..... Fraxinus ..... 17.

1. *Carya ovata* (shag-bark hickory)—Ectotrophic mycorrhizas abundant, often yellow but sometimes white or brown. Ultimate branches moderately fine. Growing tips soon becoming brown. Bark distinctly red when scraped. The general appearance of these roots is similar to that of red oak and basswood but they are distinguished from the latter by the red color of the bark.

2. *Carpinus caroliniana* (blue beech) — Ectotrophic mycorrhizas abundant, usually white. Ultimate branches moderately fine. Growing tips soon brown. Bark yellow when scraped. Distinguished from oak, hickory and basswood by the color of the bark.

3. *Quercus rubra* (red oak) and *muhlenbergii* (yellow or chestnut oak)—Ectotrophic mycorrhizas abundant, more often white though sometimes brown. Ultimate branches moderately fine. Growing tips soon becoming brown. Bark distinctly brown when scraped.

4. *Tilia americana* (basswood)—The roots of the basswood very closely resemble those of the oaks. It is difficult in most cases to distinguish them. The difference noted in the key is that the mycorrhizas of basswood are more

often brown while those of the oaks are more often white but it must be admitted that this is not a constant or dependable difference.

5. *Ulmus americana* (American elm) — Ectotrophic mycorrhizas present but usually not abundant, usually light brown in color. Ultimate branches fine. Growing tips whitish but soon becoming brown. Bark brown when scraped.

6. *Carya cordiformis* (pignut hickory) — Ectotrophic mycorrhizas present but not abundant. Ultimate branches intermediate in size. Growing tips creamy white. Bark creamy white when scraped.

7. *Celtis occidentalis* (hackberry) — Ectotrophic mycorrhizas present but not abundant. Ultimate branches very fine. Growing tips whitish, usually rather short. Bark yellowish when scraped.

8. *Aesculus glabra* (buckeye)—Ectotrophic mycorrhizas present but not abundant. Ultimate branches very coarse. Growing tips soon becoming gray. The older bark is easily peeled off in flakes or layers, the outer layers being soft and punky. Bark yellowish, sometimes tinged with pink.

9. *Acer saccharum* (hard maple), *A. saccharinum* (silvermaple) and *A. rubrum* (red maple)—Ectotrophic mycorrhizas lacking. Endotrophic mycorrhizal beads present, usually more abundant and conspicuous in the soft maples than in the hard maple. Ultimate branches intermediate in size. Growing tips remaining whitish for some time. Bark brown when scraped.

10. *Cercis canadensis* (red bud)—Mycorrhizas lacking. Ultimate branches fine. Growing tips whitish. Thick-walled root hairs present but not abundant. Bark light tan when scraped.

11. *Gleditsia triacanthos* (honey locust) — Mycorrhizas lacking. Ultimate branches coarse. Growing tips soon becoming brown. Thick-walled root hairs very abundant. Bark light brown when scraped.

12. *Gymnocladus dioica* (coffee tree) — Mycorrhizas lacking. Ultimate branches coarse. Growing tips whitish but soon becoming brown. Thick-walled root hairs present but not abundant. Bark dark tan when scraped.

13. *Juglans nigra* (walnut) and *J. cinerea* (butternut) —Mycorrhizas ordinarily lacking. Ultimate branches intermediate in size. Growing tips rather dark gray. Roots when broken or crushed having a distinct odor of walnuts. Bark yellow when scraped.

14. *Morus alba* (white mulberry)—Mycorrhizas lacking. Ultimate branches fine. Growing tips yellowish. Bark yellow to orange when scraped.

15. *Asimina triloba* (pawpaw) — Mycorrhizas lacking. Ultimate branches very coarse. Growing tips dark brown. Bark black when scraped.

16. *Benzoin melissaefolium* (spice bush)—Mycorrhizas lacking. Ultimate branches coarse. Growing tips light brown. Bark dark brown when scraped.

The spice bush never becomes a tree but it is included here because it occurs very abundantly along with the trees considered.

17. *Fraxinus americana* (white ash) and *F. quadrangulata* (blue ash)—Mycorrhizas lacking. Ultimate branches coarse. Growing tips dull white. Bark creamy white when scraped.