Mycorrhizae

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Mycorrhizae, a mutual partnership between certain soil fungi and fine root tips, contribute to tree growth and vigor by increasing both water and nutrient uptake, especially nitrogen (N) and phosphorus (P). The fungal hyphae increase root surface contact with the soil, while the fungi are supplied with a reliable source of carbon (Allen 1991, George and Marschner 1995). Two types of mycorrhizae are found on most trees—ectomycorrhizae (EM) and endomycorrhizae—also called vesicular-arbuscular mycorrhizae (VAM). The EM fungi are mainly mushroom-forming basidiomycetes, while the VAM fungi are Zygomycetes, most of which form microscopic underground spores. The majority of plants, including many trees, are colonized by VAM fungi, while EM are almost exclusively limited to woody species (Allen 1991, Mosse and others 1981). Some plants can have both VAM and EM fungi (Safir 1987).

Most research on mycorrhizae/plant relationships has been conducted on agricultural soils, upland forests, dry grasslands, or desert sites (Allen 1991). In contrast, mycorrhizal dynamics in wetland ecosystems, and especially bottomland hardwood forests, have not been well studied. Jurgensen and others (1997) reported that bottomland hardwood mycorrhizae have been studied on 14 tree species, 5 of which have VAM, 2 have EM, and 7 can have both mycorrhizal types. The majority of these studies were on sweetgum (*Liquidambar styraciflua* L.) and green ash (*Fraxinus pennsylvanica* Marsh.), important forestry and horticultural species. However, considerable work was still needed to understand mycorrhizal relationships of bottomland hardwood trees and how they affect the development and productivity of these variable and complex ecosystems. Consequently, a study was conducted on two plant community types at the Coosawhatchie Bottomland Ecosystem Study site to determine: (1) the numbers of EM and VAM roots, (2) VAM spore populations in bottomland hardwood soil, and (3) the dominant EM fungi associated with representative bottomland hardwood tree species. Information on numbers of mycorrhizal roots is presented in this paper.

Photo by Hal Liechety

Mychorrhizae were identified from soil cores.

Root and soil sampling were conducted on June 12 and 13, 1995. One soil core (30 cm long by 7.5 cm in diameter) was taken 2 to 3 m from the base of three cherrybark oaks (*Quercus falcata* var. *pagodaefolia* Ell.) and three water oaks (*Q. nigra* L.) in the drained mixed-oak (*Q.* spp.) community type, and three green ash and three water hickories (*Carya aquatica* [Michx f.] Nutt.) in the wetter swamp tupelo (*Nyssa sylvatica* var. *biflora* [Walt.] Sarg.) community type. The soil cores were divided into the following depth sections: (1) surface to 10 cm, (2) 10 cm to 20 cm, and (3) 20 cm to 30 cm. Roots were removed from each core section and weighed. The number of root tips were counted under a dissecting microscope (10–40X) and categorized as ectomycorrhizal or endomycorrhizal.

Vesicular-arbuscular mycorrhizae spores were removed from the soil by wet-sieving and then separated by size class and color. Spore size was used to separate VAM fungal genera. Spore size class 0.25 to 0.5 mm is predominately the genus *Scutellospora*. This size class also includes the genus *Gigaspora*, although current taxonomy considers this group to be of the *Scutellospora* genus (Morton and Benny 1990). Spore size class 0.062 to 0.25 mm is predominantly the genus *Glomus*. Color was used for distinguishing species within genera. Black spores within the *Glomus* genus represent *G. fecundisporum;* white to yellow spores are *G. convolutum* or *G. gigantea* (Morton 1988).

Much higher numbers of VAM spores were found in the surface 10-cm mineral soil layer than in the deeper soil layers of both plant community types (fig. 3.6), and these values were higher than has been reported for other wetland soils (Janos 1992, Rickerl and others 1994). Soil spore populations were considerably higher in the swamp tupelo soil than in the mixed-oak soil, which probably reflects the predominance of VAM tree species in the forest community. As expected, VAM spore numbers decreased as soil depth increased. The number of VAM spores in soil is often used

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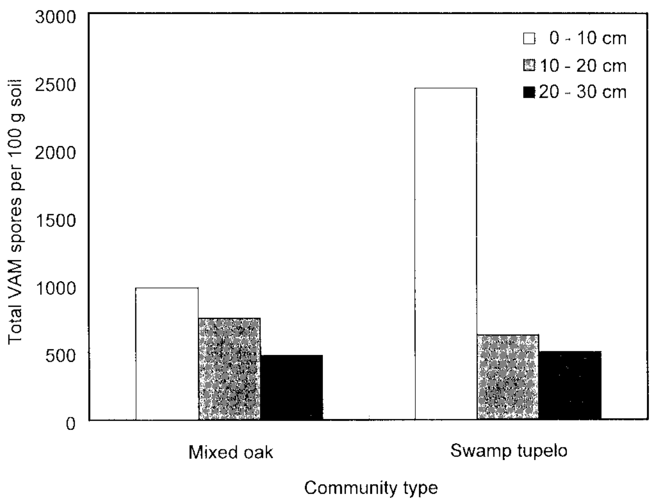

Figure 3.6—Number of endomycorrhizal (VAM) spores per 100 grams dry soil at three soil depth intervals in two community types.

as an indicator of root mycorrhizal infection (Daniels Hetrick 1984, Mosse and others 1981). However, VAM root infection may not always be reflected in spore numbers because (1) VAM spores may be dormant; (2) other infective propagules, e.g., hyphae may be present; and (3) counting spores in the soil is difficult (Abbott and Robson 1991). Also, VAM spore numbers may reflect seasonal variations and soil moisture levels at the time of sampling (Douds and Chaney 1986). Based on spore size differentiation, 90 percent of the VAM spores in both community types at the Coosawhatchie site were in the genus *Glomus*. Black spores (*G. fecundisporum*) made up between 20 to 30 percent of the total population at all soil depths. White to yellow VAM spore (*G. convolutum* or *G. gigantea*) numbers ranged from 10 to 20 percent.

Root biomass tended to be greater in the mixed-oak type than in the swamp tupelo (fig. 3.7), while the total number of root tips was higher in the swamp tupelo type (fig. 3.8). These results may reflect the rooting structure of the different plants growing in each community, or they may be anomalies from the low number of soil cores taken. The predominance of EM over VAM on roots (figs. 3.9, 3.10) was expected in the mixed-oak type, because oaks are predominately EM. However, dominant trees in the swamp tupelo type are primarily VAM (Jurgensen and others 1997), so the predominance of EM in this community suggested EM are important; again, however, this may be an artifact of a small sample size.

This preliminary investigation of mycorrhizae on the Coosawhatchie Bottomland Ecosystem Study site has indicated high levels of VAM spores in the soil of two of the community types. The occurrence of large numbers of EM in the swamp tupelo community raises questions about the significance of these mycorrhizal fungi in nutrient cycling and productivity in periodically flooded soil. Such high spore populations would seem beneficial for vegetation establishment after major site disturbance, such as harvesting or hurricane damage.

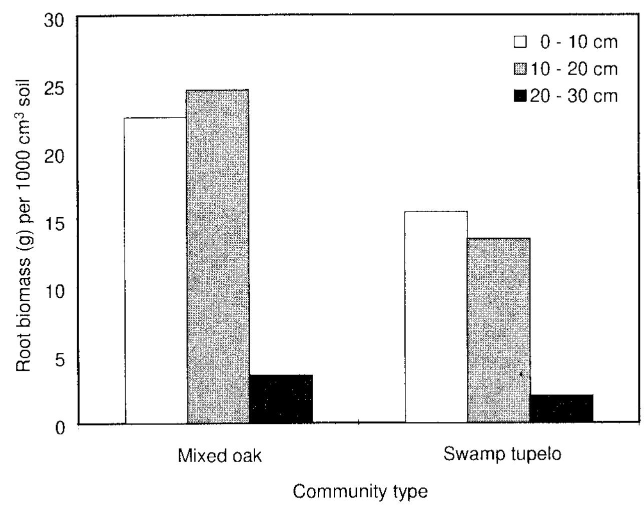

Figure 3.7—Average root biomass at three soil depth intervals in two plant community types.

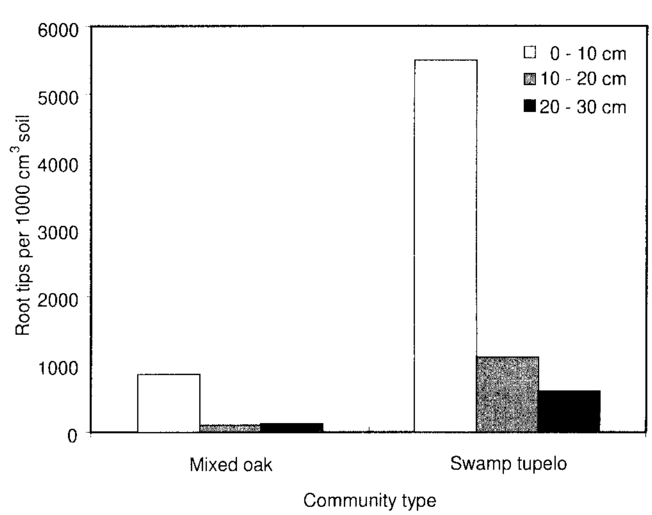

Figure 3.8—Average number of mycorrhizal root tips at three soil depth intervals in two bottomland hardwood community types.

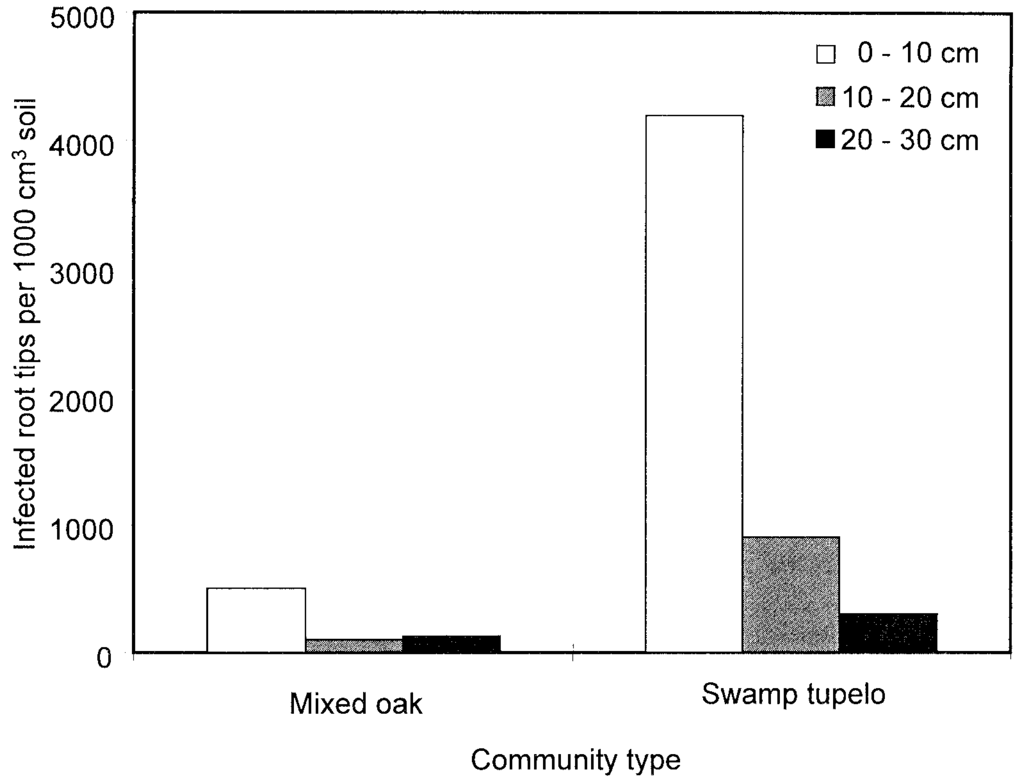

Figure 3.9—Number of ectomycorrhizal root tips at three soil depth intervals in two community types.

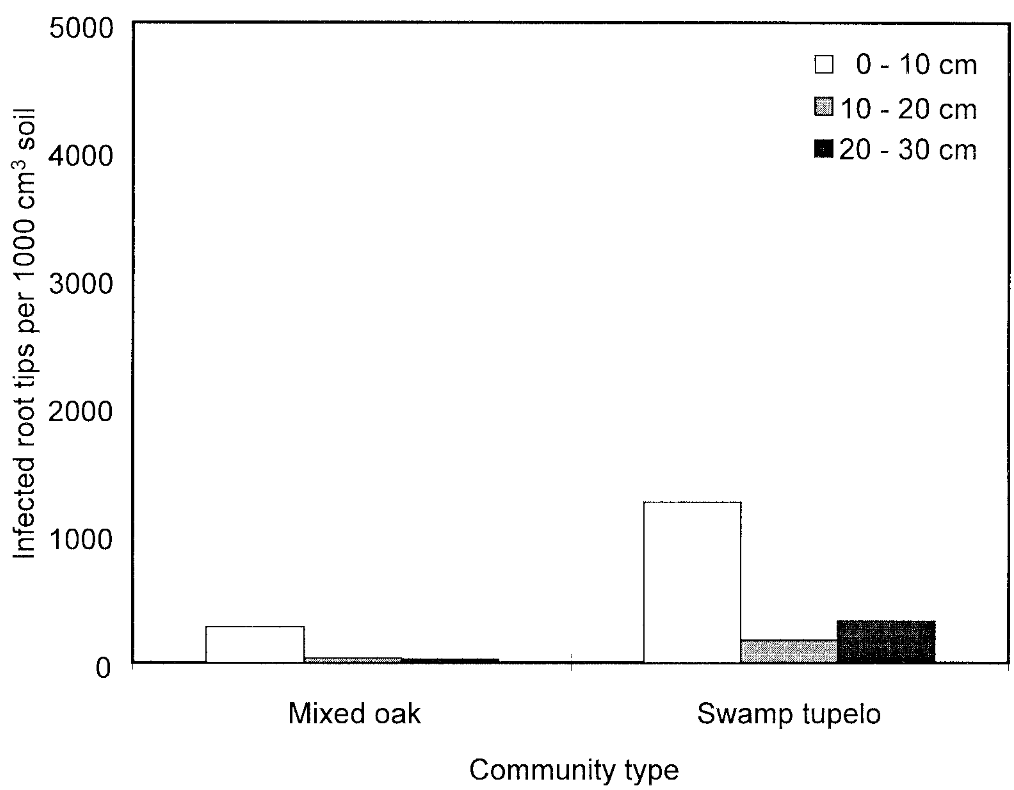

Figure 3.10—Number of endomycorrihizal root tips at three soil depth intervals in two community types.