Is root grafting a positive, cooperative behavior in trees?

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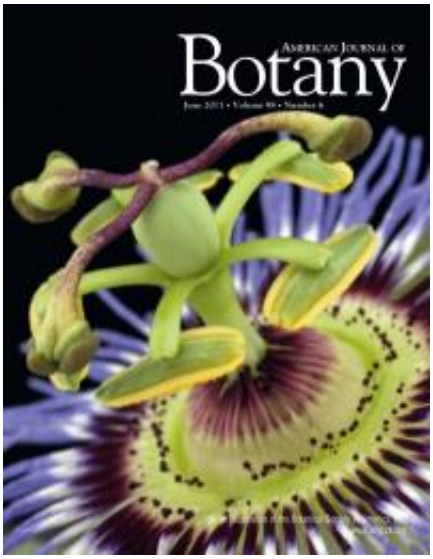

The research article was taken from the June issue of the *American Journal of Botany*. Credit: Simon T. Malcomber.

Trees are often viewed as individuals that compete with one another for access to limited resources. But could trees in stressed environments actually benefit from positive, facultative interactions? The authors of a new paper suggest that might be the case for certain tree species—and that it may take the form of root grafting.

Natural root grafting between individuals has been observed in over 150 species of plants around the world. However, while much is known about

benefits of merging stem tissues (primarily from horticultural practices), little is known about why plants may merge, or graft, their root tissues with one another.

Emilie Tarroux and Annie DesRochers, from the Université du Québec in Abitibi-Témiscamingue, Canada, were interested in determining if root grafting conferred any advantages to individual jack pine *(Pinus banksiana)* trees. Although the joining of tree root systems can confer advantages such as increased wind stability and sharing of resources e.g., water, photosynthates, or nutrients, Tarroux and DesRochers are the first to show how root grafting affects the growth of trees. They published their findings in the June issue of the *American Journal of Botany*.

"Trees, even seed-regenerated ones like jack pine, are not independent individuals," DesRochers commented, "and may directly affect growth of their neighbors by forming root grafts."

After felling select jack pine trees in three natural stands and three plantations, Tarroux and DesRochers hydraulically excavated their root systems using a high-pressure water spray to determine if the trees had root grafts. They then aged the trees, roots, and grafts by counting and cross-dating their respective growth rings.

Interestingly, the authors found that radial growth patterns differed between jack pine trees growing naturally versus those grown in plantations. In the natural stands, there were more root grafts per individual tree than in the plantations, and growth of these trees slowed down when they were forming root grafts with other trees, but then resumed or gradually increased their rate of growth once the root graft was established. In contrast, root grafting in the evenly spaced plantations seemed to have less of an effect on growth rates.

The authors also discovered that trees which would later form root grafts

tended to have better growth rates compared with trees that did not form root grafts, even prior to graft formation. Individuals may need to become large enough in order to have enough energy to complete a root graft, or so their root systems are able to come into contact with those of other trees. Conversely, smaller, weaker trees may lack energy to form root grafts, or they may not have very extensive root systems.

So what are some of the advantages of joining root systems with another tree?

"Root grafting could give an evolutionary advantage to the species," said DesRochers. "For example, it could allow well-located trees to support trees that grow in drier or poorer environments. This has been known for herbaceous species that propagate vegetatively, but has rarely been addressed in trees."

Indeed, if the larger trees facilitated acquisition of resources among conspecifics in the stand, they could maintain stand integrity; supplying carbohydrates to suppressed trees could deter tree death that would create gaps in the stand which would then allow other species to invade. Such root grafting behavior could be viewed as the formation of a communal root system, enhancing conspecific growth within the stand. This challenges the typical competition outlook, and could be interpreted as an intraspecific cooperative behavior that maintains stand integrity.

"Interestingly, we also found a couple of root grafts between jack pine and black spruce during the excavation of the sites," noted DesRochers. "Mentions of interspecific grafts are absent from the literature and makes us question the evolutionary significance of these grafts. Unfortunately, we haven't found any more since—and we have searched!."

"The next step in our research is to study the ecological significance of

these root grafts," concludes DesRochers. "Among other things, we'd like to see how much, how far, and what substances (photosynthates, water, hormones, etc.) are shared between interconnected trees."

More information: Tarroux, Emilie, and Annie DesRochers. (2011). Effect of natural root grafting on growth response of jack pine (Pinus banksiana; Pinaceae). *American Journal of Botany* 98(6): 967-974. DOI: 10.3732/ajb.1000261

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