New Theory Disproves Leonardo Da Vinci's 'Rule of Trees'

New model to calculate carbon uptake by trees illustrates why large trees may be more susceptible to drought

UNITED KINGDOM, September 19, 2023 /EINPresswire.com/ -- A 'Rule of Trees' developed by Leonardo da Vinci to describe how to draw trees has been largely adopted by science when modelling trees and how they function.

Now, scientists at Bangor University in the UK and the Swedish University of Agricultural Sciences (SLU) have discovered that this rule contradicts those that regulate the internal structures of trees.

Da Vinci's interest in drawing led him to look at size ratios of different objects, including trees, so that he could create more accurate representations of them. To correctly represent trees, he perceived a so-called 'Rule of trees' which states that "all the branches of a tree at every stage of its height are equal in thickness to the trunk when put together."

It had been thought that Leonardo's 'Rule of Trees' could also be applied to the vascular channels which transport water through a tree, with the individual channel sizes decreasing at the same ratio, as branches become narrower, while still adding up to the trunk's volume. This 'rule' had been accepted as part of metabolic scaling theory.

But scientists from Bangor University and SLU publishing in the prestigious peer-reviewed journal PNAS (18 September 2023,

www.pnas.org/doi/10.1073/pnas.2215047120), have shown that this model isn't exactly correct when applied to the internal vascular structures of trees.

For water and nutrients to move efficiently through the tree, from root to leaf-tip, the vascular system has to maintain 'hydraulic resistance'.

Ruben Valbuena and Stuart Sopp of Bangor University and SLU have calculated that for hydraulic resistance to work, there comes a point where the 'Rule of Trees' can no longer hold true.

In order to efficiently transport liquids from roots to leaf-tips, a tree's vascular channels need to maintain a certain dimension to maintain hydraulic resistance. Therefore, the plant has to reduce in its volume as it reaches its extremities, causing a higher ratio of capillary to the surrounding plant mass.

As Dr Ruben Valbuena (Honorary Professor at Bangor University and now Professor at SLU) explains,

"While a great 'tip' for artists, which is what Da Vinci intended, Leonardo's Rule of trees does not hold up at the micro level".

"We believe our calculations further refine metabolic scaling theory and improve understanding the plant system as a whole. Our re-calculations may also explain why large trees are more susceptible to drought, and may also be at a greater vulnerability to climate change."

Co-author Stuart Sopp, currently studying for his PhD in Environmental Science at Bangor University said:

"One of our aims was to produce a ratio which could be used to estimate tree biomass and carbon in forests. This new ratio will assist in calculating global carbon capture by trees."

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Title: Plant allometry derived from Metabolic Scaling Theory and segregated by tissue functionality.
Journal: Proceedings of the National Academy of Sciences of the United States of America (PNAS)
Authors: Stuart Sopp & Ruben Valbuena

Editor's notes: There is a theory in natural sciences drawn in the 1990s called metabolic scaling theory (MST). MST is the relationship between the metabolic rate in an organism and its mass. What MST basically says is that something living cannot exceed certain dimensions or proportions, or it will be unable to sustain itself. In terms of trees, sustenance mainly refers to the supply of water through its roots.

One consequence of MST is that the size of organisms are regulated by simple scaling rules. In the case of trees, MST was largely built upon the presumption of Leonardo's 'Rule of trees' being true. So far, models of tree size have been mainly based on either hydraulics or MST. The new study in PNAS builds a new MST model based on the assumptions of hydraulic resistance, instead of Leonardo's 'Rule of trees'.

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