Understanding the role of plant-microbe symbiosis in the cycling of carbon (C) in temperate forest ecosystems

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Presentation overview

- Project background
- Why is it important?
- What have I been doing?
- Chapter 2- Key findings
- Conclusions

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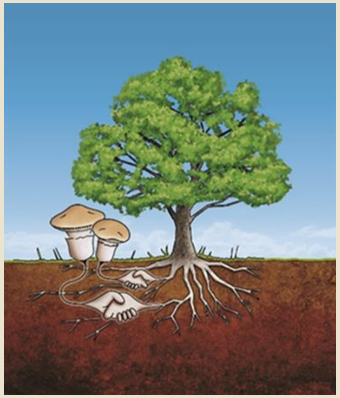
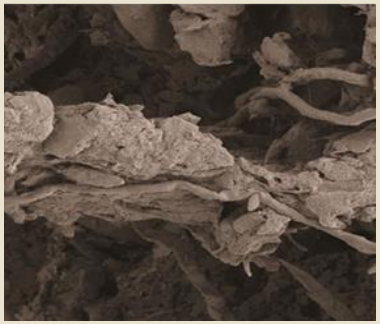
What is plant-microbe symbiosis and are they important?



"a plant living in close association with one or more micro-organisms" (de Bary, 1879)

Temperate examples-

Nitrogen-fixing bacteria

- Second most important biological process

Mycorrhizal fungi

- Improve nutrition by increasing the available soil volume by up to x 700
- Increase survival rates
- Some can release nutrients from mineral rock
- Used for communication- warn of pest and disease attack

Which trees did I study?

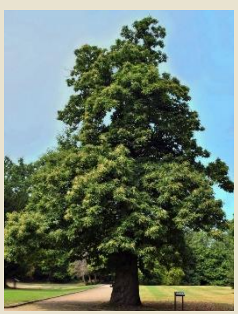
A) Alder (*Alnus glutinosa*)

Bacteria symbiosis (*Frankia alni*) nitrogen fixers located in root nodules.

Fungal symbiosis- ecto and arbuscular mycorrhizal

B) Silver birch (*Betula pendula*)

Fungal symbiosis- ectomycorrhizal



C) Sweet chestnut (*Castanea sativa*)

Fungal associations- ectomycorrhizal.

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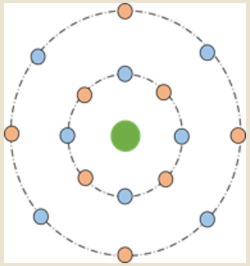
What have I been doing?

- Experiment 1- Carbon partition experiment- quantified carbon transferred to mycorrhizae
- Experiment 2- CMN experiment- inter and intra specific carbon transfer
- Experiment 3- Quantified carbon transfer to root nodules in alder (*Alnus glutinosa*)
- Experiment 4a- Field carbon partition experiment for comparison to lab exp
- Experiment 4b- Transfer of carbon from tree to ground vegetation via CMN



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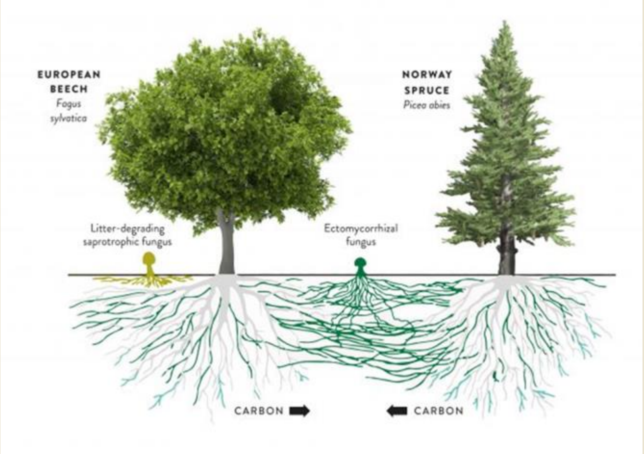
Experiment 2: Common Mycorrhizal Network

CMN can transfer-
- Carbon, water, nutrients, minerals, defence signals, defence compounds, allelochemicals

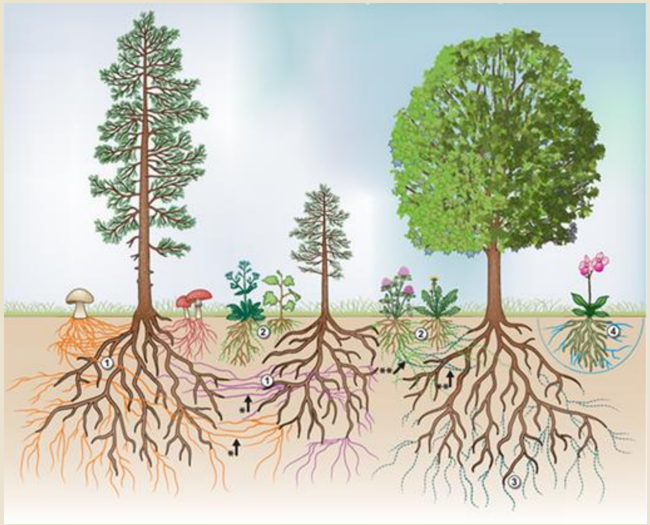
- Known as Wood Wide Web

We don’t yet know-
- How much carbon is transferred across common mycorrhizal network?
- Do trees of the same species transfer more or less carbon across mycorrhizal networks than those of differing species?

Hypothesis- Common hyphal networks connecting trees of the same species will transfer more recently photosynthesised carbon than that connect two differing species (inter and intra specific transfer)



(Hansford, 2017)

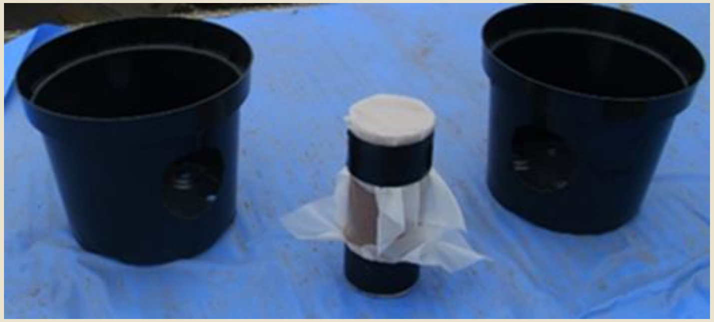


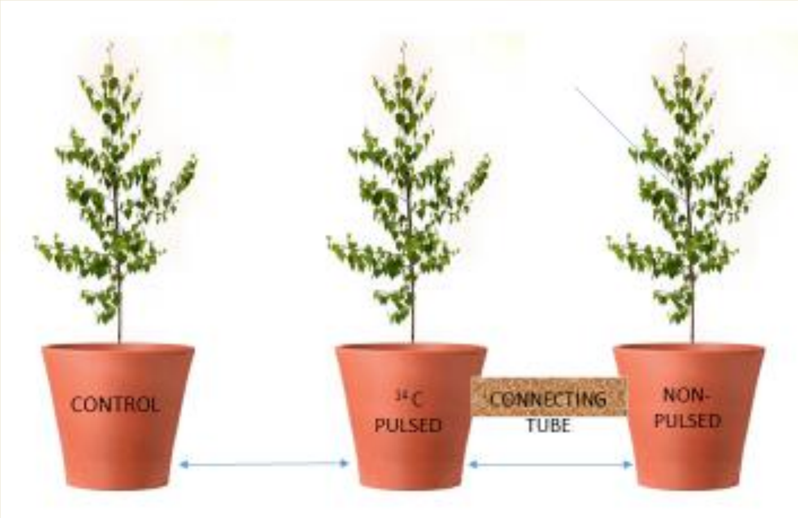
(Van der Heijden et al, 2014)

Experiment 2: Common Mycorrhizal Network

Experimental design summary

- Pots are joined with tube
- Tubes contained sand and phosphorus (bone-meal)
- x4 replicates of each combination
- Random block arrangement
- One of the trees labelled with $^{14}CO_2$
- Potted for 9 months before pulse





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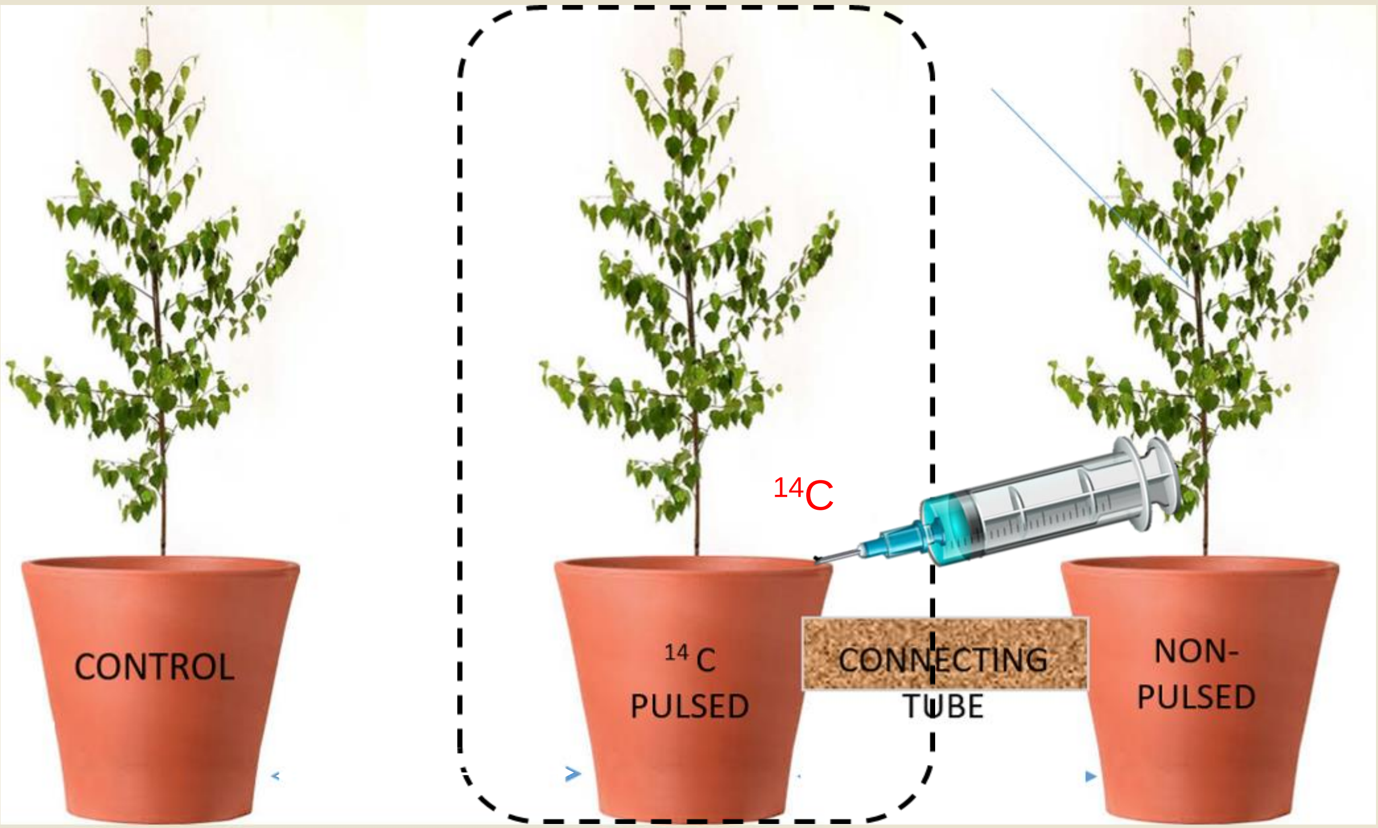
Experiment 2: Common Mycorrhizal Network (CMN) - Method



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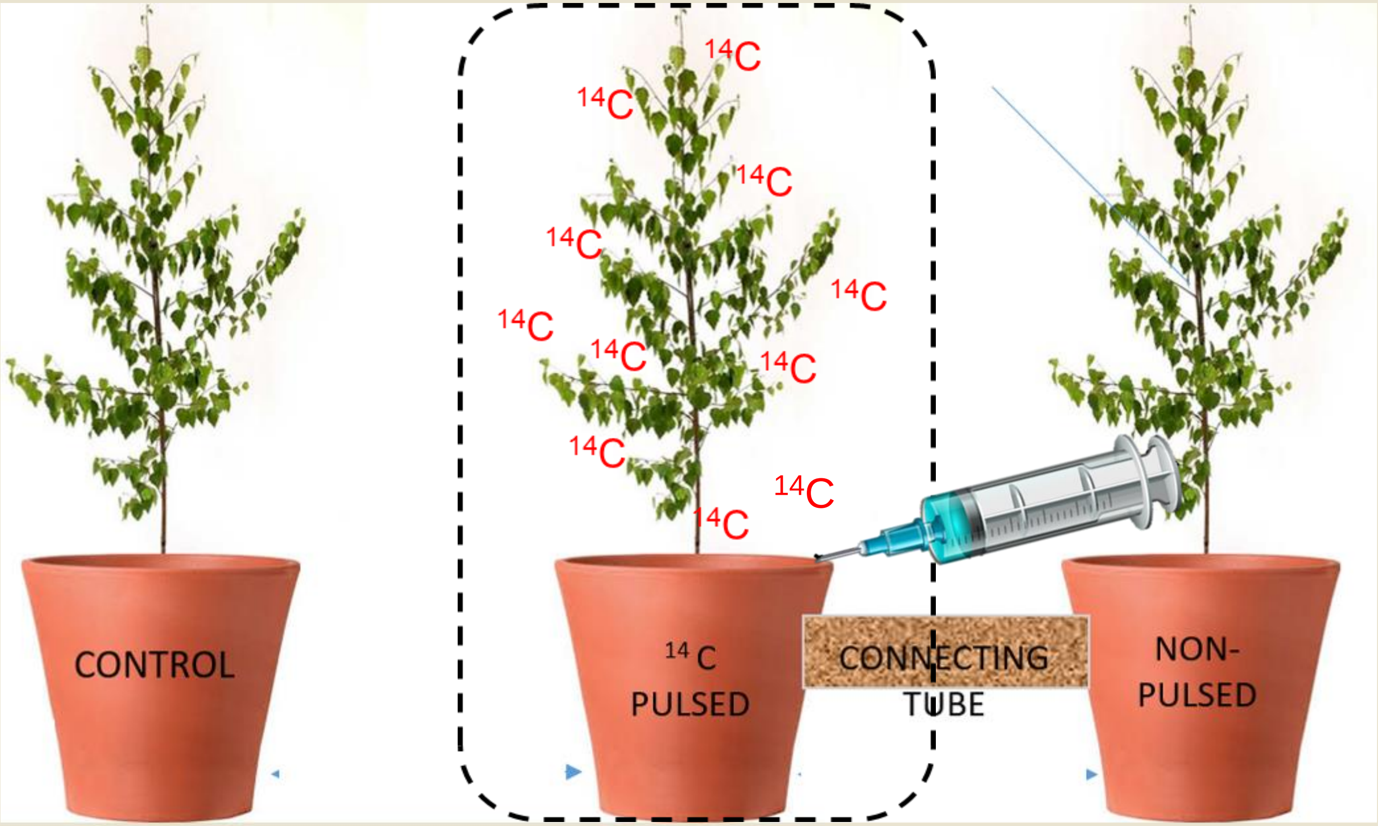

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Experiment 2: Common Mycorrhizal Network (CMN) - Samples

Labelled trees
L1- New leaves
L2- Old leaves
B- Branch + stem
R- Root
Soil
Soil resp. traps
Soil water- rhizon

Non-labelled trees
L1- New leaves
L2- Old leaves
B- Branch and stem
R- Root
Soil
Soil resp. traps
Soil water- rhizon

Additional samples
Interconnecting sand
Soil + sand fungal DNA extracted

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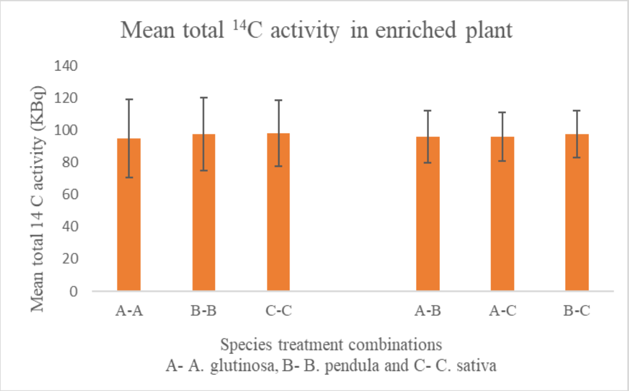
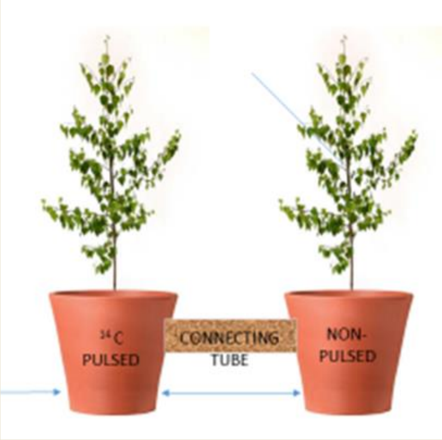
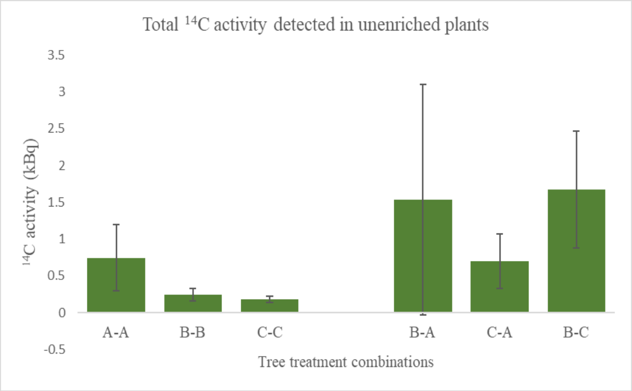
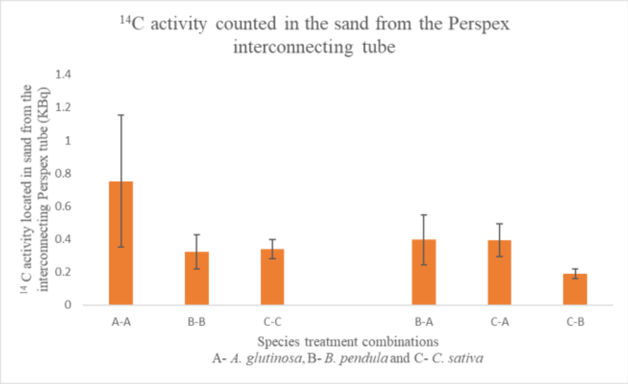
Experiment 2: Differences in ^{14}C transferred through tube









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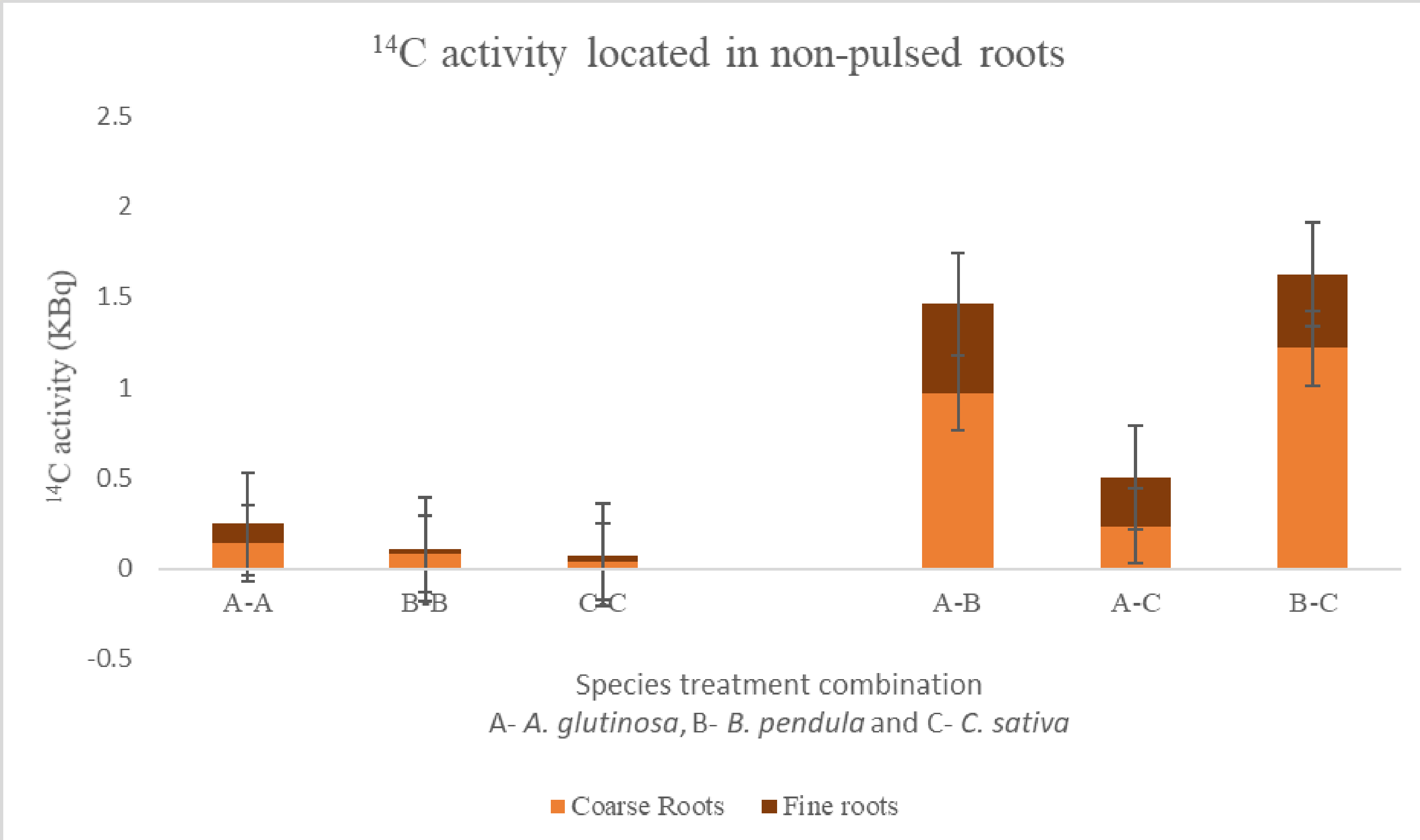
Experiment 2: Differences in ^{14}C allocation



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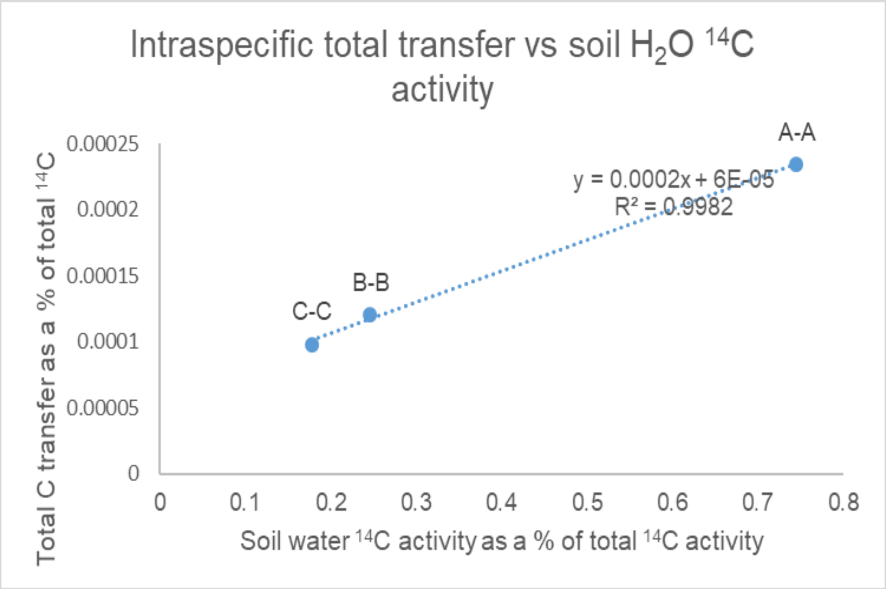
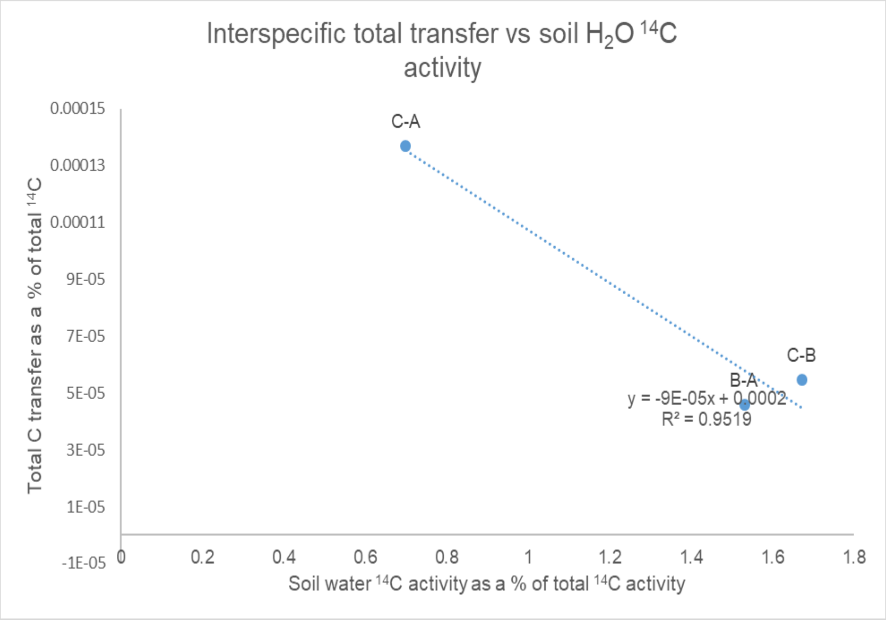
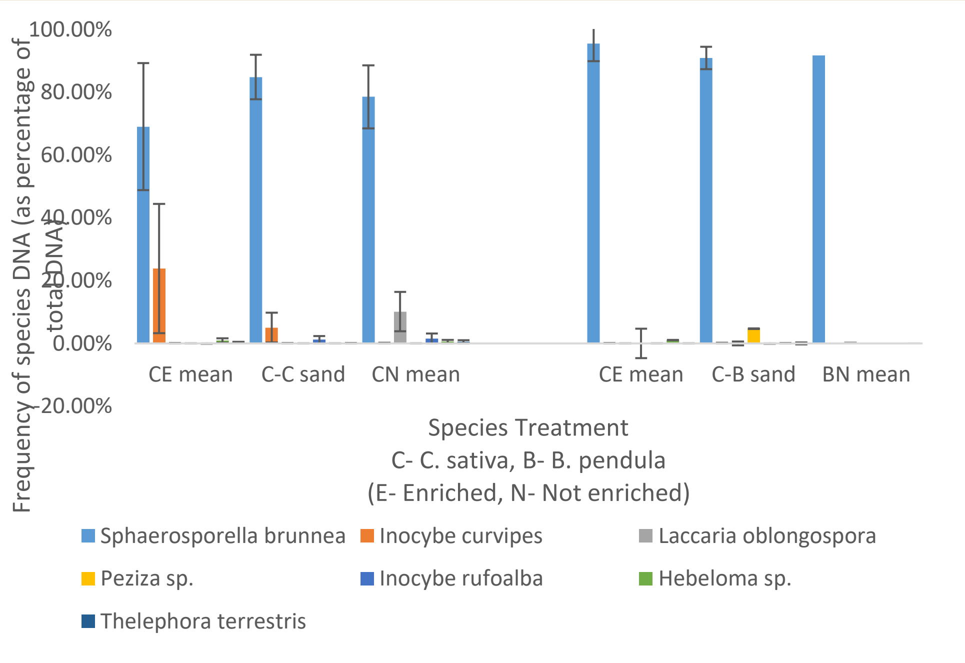
Experiment 2: Differences in total respiration vs. unenriched respiration





Experiment 2: Fungal DNA data

Inocybe curvipes



Laccaria oblongospora

Sphaerosporella brunnea

Peziza sp.

Inocybe rufoalba

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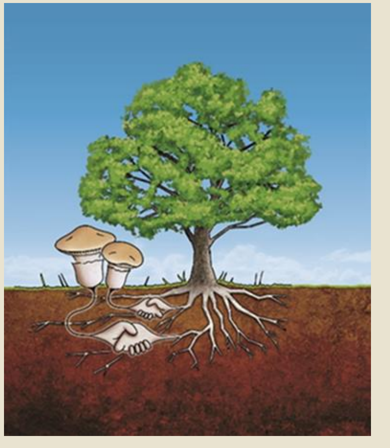
Common Mycorrhizal Network Key findings/ conclusions



- More carbon transferred between trees of different than the same species via CMN
- Carbon source-sink relationships are likely to be driving C allocation between trees via CMN
- Cup Fungus *Sphaerosporella brunnea* most likely responsible for majority of ^{14}C transfer
- Resource sharing via CMN could have important implications for plant community dynamics and forest ecosystem function
- Plant: microbe symbiosis may be more important in mediating plant community diversity, population dynamics, successional trajectory and evolution than previously thought

Thanks for listening
Any questions?

References

De Bary, A., 1879. Die erscheinung der symbiose. Verlag von Karl J. Trübner.

Images

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