Supplementary material II-S9

Expected causal relationships

Response variable	Explanatory variable	Hypothesis [Reference from the main text]
Basal respiration	Total microbial biomass	Increasing soil microbial biomass should increase basal respiration [19]
Basal respiration	Active microbial biomass	Increasing active soil microbial biomass should increase basal respiration [19]
Basal respiration	B:F	Increasing B:F is expected to increase microbial community activity and thereafter, respiration [7-10]
Basal respiration	Bacteria diversity	Bacteria diversity should increase microbial respiration by increasing resource use [7-10]
Basal respiration	Fungi diversity	Fungi diversity should increase microbial respiration by increasing resource use [7-10]
Basal respiration	Cata	Increasing catabolism functional genes abundance (i.e. Cata) should increase microbial respiration by increasing the genetic material supporting the catabolism processes [30, 36]
Basal respiration	FG evenness	Increasing catabolism functional gene evenness should increase microbial respiration by increasing the physiological pathways supported by the genetic material [30, 36]
Basal respiration	SIR efficiency	Increasing microbial SIR efficiency should increase microbial respiration due to a higher number of physiological pathways supported [40 - 41]
Basal respiration	SIR range	Increasing microbial SIR range should increase microbial respiration due to a stronger response of the microbial community to complex substrates with longer pathways [40 - 41]
Basal respiration	TOC	Soil chemical properties affect soil functions by changing resource limitations and physiological processes [12, 13, 25, 26, 46]
Basal respiration	C:N	Soil chemical properties affect soil functions by changing resource limitations and physiological processes [12, 13, 25, 26, 46]
Basal respiration	C:P	Soil chemical properties affect soil functions by changing resource limitations and physiological processes [12, 13, 25, 26, 46]
Basal respiration	pH	Soil chemical properties affect soil functions by changing resource limitations and physiological processes [12, 13, 25, 26, 46]
Basal respiration	RH	Soil chemical properties affect soil functions by changing resource limitations and physiological processes [12, 13, 25, 26, 46]

Basal respiration	Tree species richness	Increasing tree species richness should increase microbial respiration by providing a higher amount and diversity of substrates [11, 21-22, 24]
SIR efficiency	Biomass	Increasing microbial biomass should increase SIR efficiency by reducing microbial lag time before the exponential growth [19, 45]
SIR efficiency	Active microbial biomass	Increasing microbial biomass should increase SIR efficiency by reducing microbial lag time before the exponential growth [19, 45]
SIR efficiency	B:F	Changes in microbial community composition are expected to affect microbial processes [42 - 44]
SIR efficiency	Bacteria diversity	Changes in microbial community composition are expected to affect microbial processes [42 - 44]
SIR efficiency	Fungi diversity	Changes in microbial community composition are expected to affect microbial processes [42 - 44]
SIR efficiency	Cata	Increasing catabolism functional genes should increase SIR efficiency by reducing microbial lag time before the exponential growth [37, 39]
SIR efficiency	FG evenness	Increasing catabolism functional gene evenness should increase SIR efficiency by optimizing all physiological pathways [37, 39]
SIR efficiency	TOC	Soil chemical properties affect soil functions by changing resource limitations and physiological processes [12, 13, 25, 26, 27]
SIR efficiency	C:N	Soil chemical properties affect soil functions by changing resource limitations and physiological processes [12, 13, 25, 26]
SIR efficiency	C:P	Soil chemical properties affect soil functions by changing resource limitations and physiological processes [12, 13, 25, 26]
SIR efficiency	pH	Soil chemical properties affect soil functions by changing resource limitations and physiological processes [12, 13, 25, 26]
SIR efficiency	RH	Soil chemical properties affect soil functions by changing resource limitations and physiological processes [12, 13, 25, 26]
SIR efficiency	Tree species richness	Increasing tree species richness should increase microbial physiological potential by providing a higher amount and diversity of substrates [11, 21-22, 24]
SIR range	Biomass	Increasing microbial biomass should increase SIR range by reducing microbial lag time before the exponential growth and favor long physiological pathways [19, 45]
SIR range	Active microbial biomass	Increasing microbial biomass should increase SIR efficiency by reducing microbial lag time before the exponential growth [19, 45]
SIR range	B:F	Changes in microbial community composition are expected to affect microbial processes [42 - 44]
SIR range	Bacteria diversity	Changes in microbial community composition are expected to affect microbial processes [42 - 44]
SIR range	Fungi diversity	Changes in microbial community composition are expected to affect microbial processes [42 - 44]

SIR range	Cata	Increasing catabolism functional genes should increase SIR range by reducing microbial lag before the exponential growth and favor long physiological pathways [37, 39]
SIR range	FG evenness	Increasing catabolism functional gene evenness should increase SIR range by optimizing all physiological pathways [37, 39]
SIR range	TOC	Soil chemical properties affect soil microbial functions (such as microbial growth) by changing resource limitations and physiological processes [13]
SIR range	C:N	Soil chemical properties affect soil microbial functions (such as microbial growth) by changing resource limitations and physiological processes [13]
SIR range	C:P	Soil chemical properties affect soil microbial functions (such as microbial growth) by changing resource limitations and physiological processes [13]
SIR range	pH	Soil chemical properties affect soil microbial functions (such as microbial growth) by changing resource limitations and physiological processes [13]
SIR range	RH	Soil chemical properties affect soil microbial functions (such as microbial growth) by changing resource limitations and physiological processes [13]
SIR range	Tree species richness	Increasing tree species richness should increase microbial physiological potential by providing a higher amount and diversity of substrates [11, 21-22, 24]
Biomass	TOC	Soil chemical properties affect soil microbial functions (such as microbial growth) by affecting resource limitations and physiological processes [13]
Biomass	C:N	Soil chemical properties affect soil microbial functions (such as microbial growth) by affecting resource limitations and physiological processes [13]
Biomass	C:P	Soil chemical properties affect soil microbial functions (such as microbial growth) by affecting resource limitations and physiological processes [13]
Biomass	pH	Soil chemical properties affect soil microbial functions (such as microbial growth) by affecting resource limitations and physiological processes [13]
Biomass	RH	Soil chemical properties affect soil microbial functions (such as microbial growth) by affecting resource limitations and physiological processes [13]
Biomass	Tree species richness	Increase of tree species richness should increase substrate abundance and therefore the system's carrying capacity [16, 21-22, 24]
Active microbial biomass	TOC	Soil chemical properties affect soil microbial functions (such as microbial growth) by changing resource limitations and physiological processes [13]
Active microbial biomass	C:N	Soil chemical properties affect soil microbial functions (such as microbial growth) by changing resource limitations and physiological processes [13]

Active microbial biomass	C:P	Soil chemical properties affect soil microbial functions (such as microbial growth) by changing resource limitations and physiological processes [13]
Active microbial biomass	pH	Soil chemical properties affect soil microbial functions (such as microbial growth) by changing resource limitations and physiological processes [13]
Active microbial biomass	RH	Soil chemical properties affect soil microbial functions (such as microbial growth) by changing resource limitations and physiological processes [13]
Active microbial biomass	Tree species richness	Increase of tree species richness increases substrate abundance and therefore the system's carrying capacity [21-22]
B:F	TOC	Soil chemical properties shape microbial community structure [13, 16]
B:F	C:N	Soil chemical properties shape microbial community structure [13, 16]
B:F	C:P	Soil chemical properties shape microbial community structure [13, 16]
B:F	pH	Soil chemical properties shape microbial community structure [13, 16]
B:F	RH	Soil chemical properties shape microbial community structure [13, 16]
B:F	Tree species richness	Tree species richness should increase bacteria to fungi ratio [21]
Bacteria diversity	TOC	Soil chemical properties shape microbial community structure [13, 16]
Bacteria diversity	C:N	Soil chemical properties shape microbial community structure [13, 16]
Bacteria diversity	C:P	Soil chemical properties shape microbial community structure [13, 16]
Bacteria diversity	pH	Soil chemical properties shape microbial community structure [13, 16]
Bacteria diversity	RH	Soil chemical properties shape microbial community structure [13, 16]
Bacteria diversity	Tree species richness	Increase of tree species richness increases substrate diversity and therefore functional niche complementarity [21-22]
Fungi diversity	TOC	Soil chemical properties shape microbial community structure [13, 16]
Fungi diversity	C:N	Soil chemical properties shape microbial community structure [13, 16]
Fungi diversity	C:P	Soil chemical properties shape microbial community structure [13, 16]
Fungi diversity	pH	Soil chemical properties shape microbial community structure [13, 16]
Fungi diversity	RH	Soil chemical properties shape microbial community structure [13, 16]
Fungi diversity	Tree species richness	Increase of tree species richness increases substrate diversity and therefore functional niche complementarity [21-22]
Cata	TOC	Soil chemical properties shape microbial community structure [12, 13, 25, 26, 30-32]
Cata	C:N	Soil chemical properties shape microbial community structure [12, 13, 25, 26, 30-32]
Cata	C:P	Soil chemical properties shape microbial community structure [12, 13, 25, 26, 30-32]
Cata	pH	Soil chemical properties shape microbial community structure [12, 13, 25, 26, 30-32]

Cata	RH	Soil chemical properties shape microbial community structure [12, 13, 25, 26, 30-32]
Cata	Tree species richness	Increase of tree species richness increases substrate diversity and therefore functional niche complementarity [21-22]
FG evenness	TOC	Soil chemical properties affect soil microbial community composition by changing resource limitations and therefore species selection [12, 13, 25, 26, 30-32]
FG evenness	C:N	Soil chemical properties affect soil microbial community composition by changing resource limitations and therefore species selection [12, 13, 25, 26, 30-32]
FG evenness	C:P	Soil chemical properties affect soil microbial community composition by changing resource limitations and therefore species selection [12, 13, 25, 26, 30-32]
FG evenness	pH	Soil chemical properties affect soil microbial community composition by changing resource limitations and therefore species selection [12, 13, 25, 26, 30-32]
FG evenness	RH	Soil chemical properties affect soil microbial community composition by changing resource limitations and therefore species selection [12, 13, 25, 26, 30-32]
FG evenness	Tree species richness	Increasing tree species richness increases substrate diversity and therefore functional niche complementarity [21-22]

Correlations (relationships where directionality of effects is not clear from the literature)

First variable	Second variable	Hypothesis [Reference from the main text]
Biomass	Active microbial biomass	We expect the biomass of active microbes to increase with increasing total microbial biomass
Biomass	B:F	We expect the B:F ratio to positively correlate with the microbial biomass
Biomass	Bacteria diversity	We expect a positive biomass ~ diversity relationship
Biomass	Fungi diversity	We expect a positive biomass ~ diversity relationship
Biomass	Cata	The number of genes copies is expected to increase with the number of cells
Biomass	FG evenness	We expect a positive biomass ~ diversity relationship
Active microbial biomass	B:F	We expect the B:F ratio to positively correlate with the microbial biomass
Active microbial biomass	Bacteria diversity	We expect a positive biomass ~ diversity relationship

Active microbial biomass	Fungi diversity	We expect a positive biomass ~ diversity relationship
Active microbial biomass	Cata	The number of genes copies is expected to increase with the number of cells
Active microbial biomass	FG evenness	We expect a positive biomass ~ diversity relationship
B:F	Bacteria diversity	We expect a positive biomass ~ diversity relationship, which also implies a positive B:F ~ bacteria diversity relationship
B:F	Fungi diversity	We expect a positive biomass ~ diversity relationship, which also implies a positive B:F ~ bacteria diversity relationship
B:F	Cata	We expect a positive relationship, as most of the measured genes are bacterial
B:F	FG evenness	We expect a positive relationship, as most of the measured genes are bacterial
Bacteria diversity	Fungi diversity	We expect bacteria and fungi diversity to be positively correlated to each another as driven by similar processes
Bacteria diversity	Cata	We expect a positive biomass ~ diversity relationship [33]
Bacteria diversity	FG evenness	We expect taxonomic and functional diversity to be strongly positively correlated to each another as driven by similar processes [33]
Fungi diversity	Cata	We expect a positive biomass ~ diversity relationship [33]
Fungi diversity	FG evenness	We expect taxonomic and functional diversity to be strongly correlated to each another as driven by similar processes [33]
Cata	FG evenness	We expect a positive biomass ~ diversity relationship
SIR efficiency	SIR range	We expect SIR range and efficiency to be positively correlated
TOC	C:N	We expect soil chemical properties to be correlated [see Scholten et al. 2017]
TOC	C:P	We expect soil chemical properties to be correlated [see Scholten et al. 2017]
TOC	pH	We expect soil chemical properties to be correlated [see Scholten et al. 2017]
TOC	RH	We expect soil chemical properties to be correlated [see Scholten et al. 2017]
TOC	Tree species richness	We expect soil chemical properties and tree species richness may be correlated; while significant tree diversity effects on soil properties can be expected, initial plot selection could also have caused non-causal relationships
C:N	C:P	We expect soil chemical properties to be correlated [see Scholten et al. 2017]
C:N	pH	We expect soil chemical properties to be correlated [see Scholten et al. 2017]
C:N	RH	We expect soil chemical properties to be correlated [see Scholten et al. 2017]

C:N	Tree species richness	We expect soil chemical properties and tree species richness may be correlated; while significant tree diversity effects on soil properties can be expected, initial plot selection could also have caused non-causal relationships
C:P	pH	We expect soil chemical properties to be correlated [see Scholten et al. 2017]
C:P	RH	We expect soil chemical properties to be correlated [see Scholten et al. 2017]
C:P	Tree species richness	We expect soil chemical properties and tree species richness may be correlated; while significant tree diversity effects on soil properties can be expected, initial plot selection could also have caused non-causal relationships
pH	RH	We expect soil chemical properties to be correlated [see Scholten et al. 2017]
pH	Tree species richness	We expect soil chemical properties and tree species richness may be correlated; while significant tree diversity effects on soil properties can be expected, initial plot selection could also have caused non-causal relationships
RH	Tree species richness	We expect soil chemical properties and tree species richness may be correlated; while significant tree diversity effects on soil properties can be expected, initial plot selection could also have caused non-causal relationships

References

REFERENCES ARE FROM THE MAIN TEXT

[Scholten et al 2017] Scholten T, *et al.* On the combined effect of soil fertility and topography on tree growth in subtropical forest ecosystems—a study from SE China. Journal of Plant Ecology 2017; 10(1): 111–27 [https://doi.org/10.1093/jpe/rtw065]