

Influence of Decomposition on Soil Microbial Metabolic Activity

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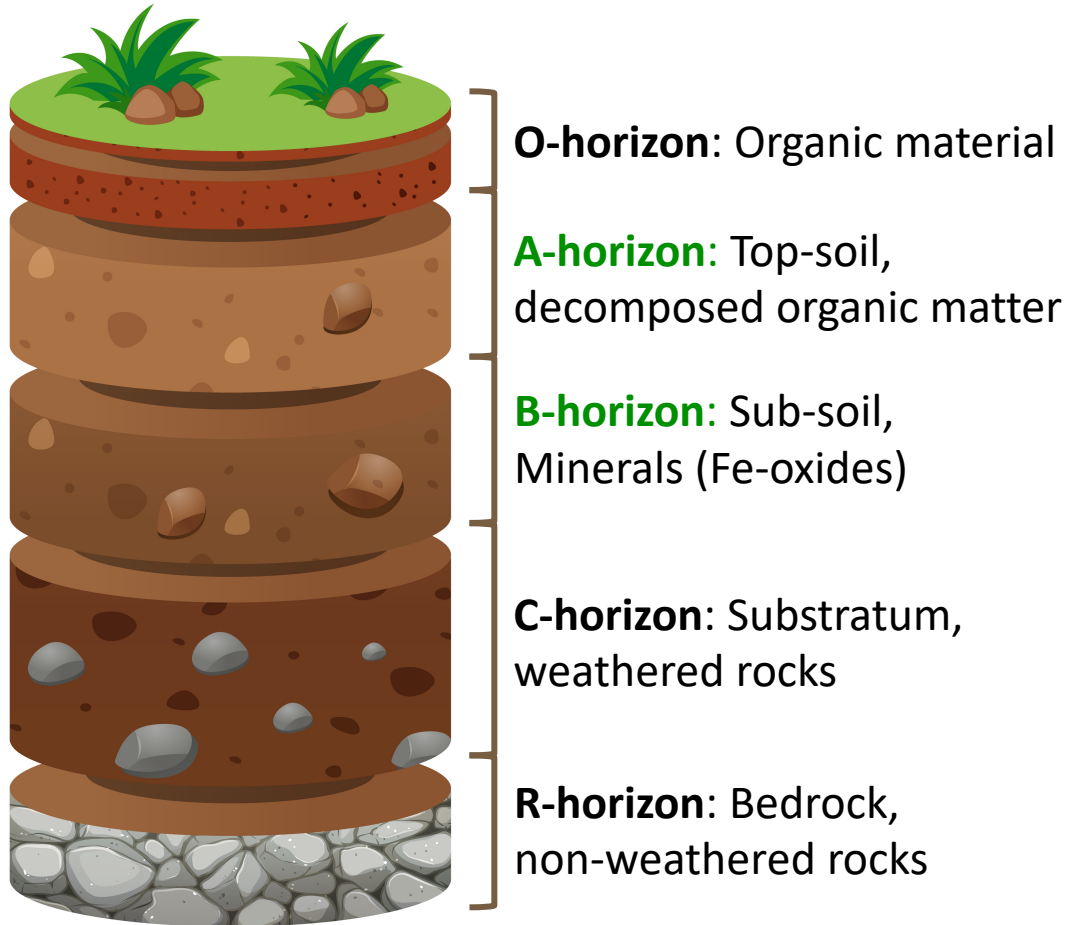


Body Decomposition



- Purging & leaching of decomposition fluids rich in biomolecules
- Formation of the **Cadaver Decomposition Island (CDI)**:
 - Fertility hot-spot (carbon, nitrogen, phosphorous)
 - Increased soil pH
 - Anaerobic conditions
 - Altered redox potentials
 - Altered microbial community

Soil & Humification



Soil & Humification



O-horizon: Organic material

A-horizon: Top-soil, decomposed organic matter

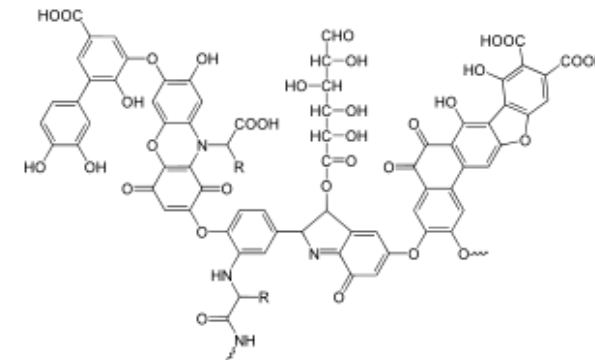
B-horizon: Sub-soil, Minerals (Fe-oxides)

C-horizon: Substratum, weathered rocks

R-horizon: Bedrock, non-weathered rocks

Humification:

- Generation and accumulation of highly decomposed organic material that is resistant to further degradation (humic-substances)
 - Large complex compounds
 - Aromatic
 - Recalcitrant / non-labile



Research Problem

- Establishment of REST[ES]
- Request by provincial ministry for environmental impact
- Literature only on CDI soil chemistry & microbial community composition
- No impact studies on ecological and environmental health and/or function



Goal & Objectives

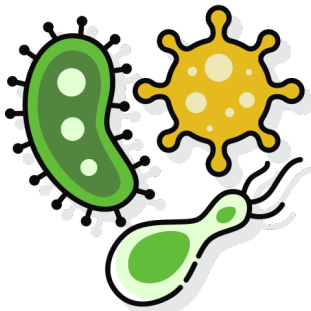
- Evaluate the potential **temporal** (season) and **spatial** (distance) environmental impact of body decomposition in a Canadian temperate climate
 - Monitor changes in **bacterial activity**
 - Monitor changes in **dissolved organic carbon (DOC)** chemistry
- Find potential correlations between body decomposition, DOC chemistry and bacterial activity
- *Optimize techniques and protocols for human trials at REST[ES]*



Approach

Why soil bacteria?

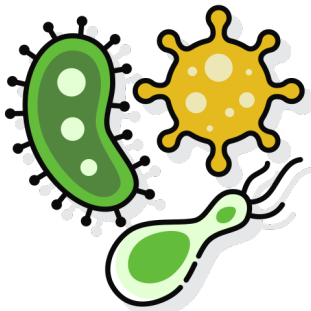
- Responsible for degrading & transforming decomposition products
- Crucial in maintaining nutrient cycles & trophic energy transfer
- Good indicators of ecological / environmental health
- Involved in decomposition processes



Approach

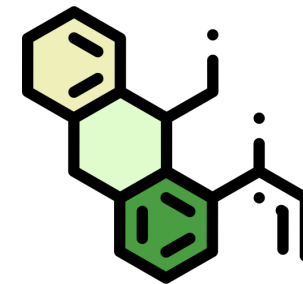
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Why dissolved organic carbon (DOC)?

- Input from body decomposition
- Biologically available fraction of carbon
- Most commonly used energy substrate aerobic microbes
- Diverse chemistry (source, lability)



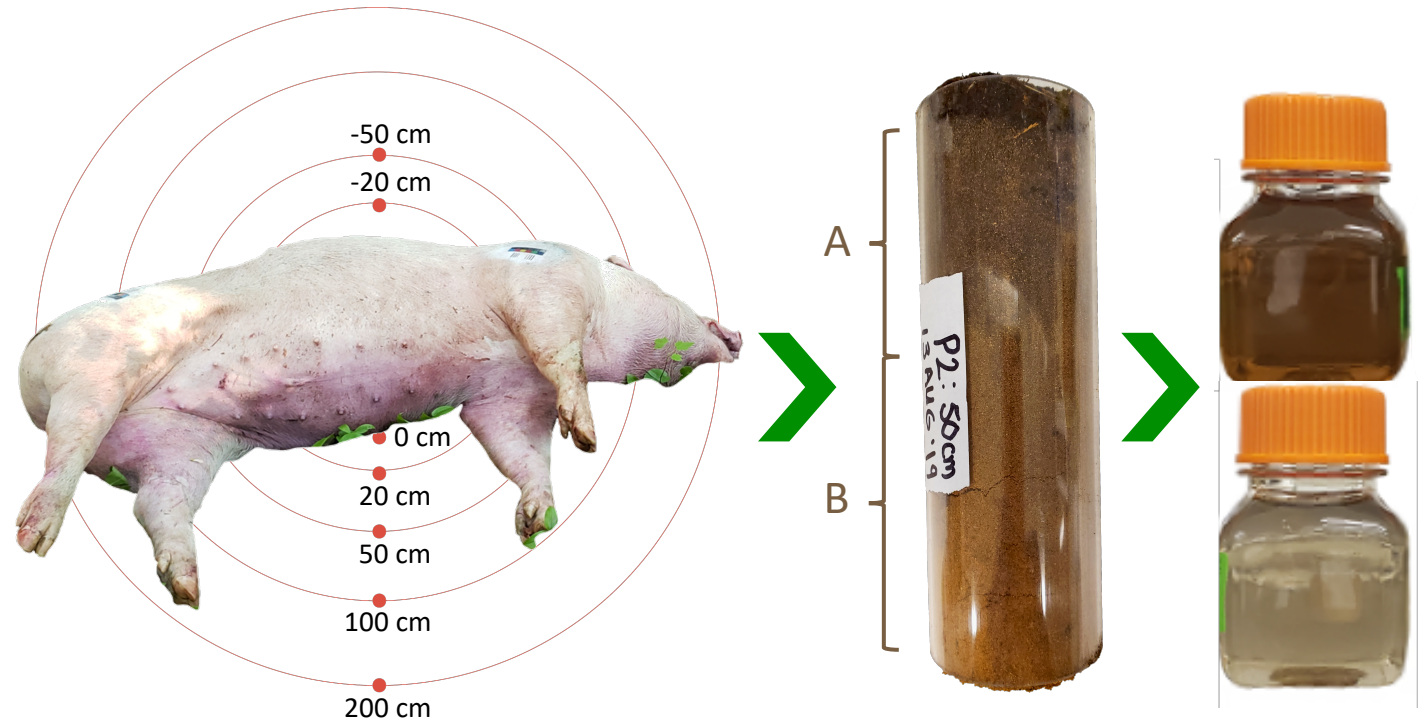
Experimental Set-up & Methods



- **UQTR Campus site**

- Mixed temperate forest
 - Sandy-loamy soil texture

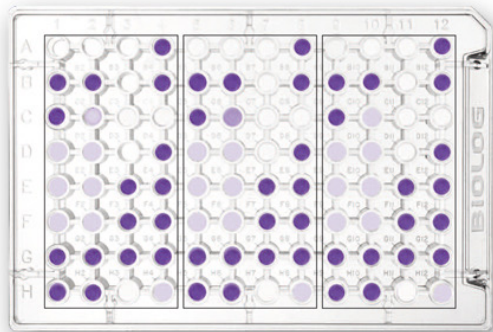
- 3 female pigs
- Surface deposited **Summer 2019**



- Soil coring (2" X 6") at varying distances
- Summer 2019, Fall 2019 & Spring 2020 (Dry remains)
- Soil divided by horizons A and B
- Soil dried and prepared into a slurry for analysis

Methods: Bacterial Analyses

Measure	Definition	Instrument / Technique
Bacterial Respiration (BR)	Rate of O ₂ consumption	Incubation (20°C) in PreSens Vials with optical O ₂ sensors (PSt5) and reader plate (SDR)
Bacterial Production (BP)	Incorporation of carbon into biomass	L-[U ¹⁴ C] Leucine incorporation method Liquid scintillation counter
Bacterial Growth Efficiency (BGE)	Efficiency at which carbon is assimilated into biomass VS being respired	$BGE = BP / (BP + BR)$
Bacterial Metabolic Capacity	Ability to degrade 31 carbon substrates	BIOLOG EcoPlates (Absorbance at 590 nm)



◀ BIOLOG EcoPlate

PreSens Vials & SDR reader



Methods: DOC Analyses

DOC Concentration



GE Sievers M9 TIC/TOC analyzer

DOC Characterization: Optical Properties

- fDOC Excitation-Emission (EMM) spectra
- Carey fluorescence/ UV absorbance spectrophotometer
- Fluorescence indices & PARAFAC modelling

Index	Calculation	Description
Fluorescence Index (FI)	Em 450 nm and 500 nm, at an Ex of 370 nm.	DOC source (microbial or terrestrial)
Humification Index (HIX)	Area under the Em 435–480 nm divided by the area under the Em 300–345 nm + 435–480 nm, at an Ex 254 nm.	Degree of humification
SUVA₂₅₄	UV absorbance at 254 nm divided by DOM concentration.	Degree of DOC aromaticity
Freshness Index (BIX)	Em 470 nm divided by Em 520 nm ,at Ex of 370 nm.	Recently produced DOC VS Decomposed DOC

Methods: DOC Analyses

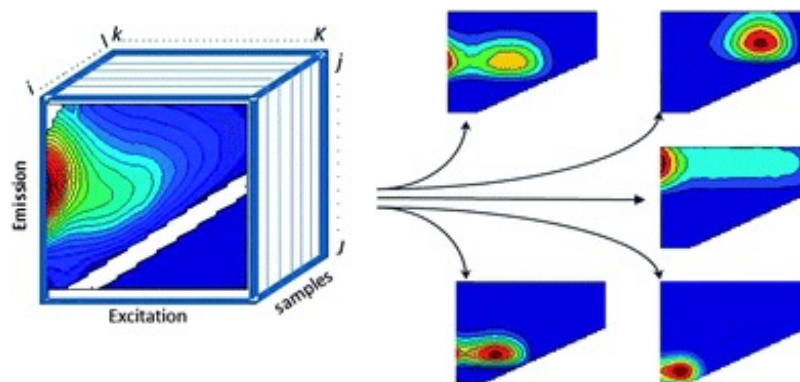
DOC Concentration



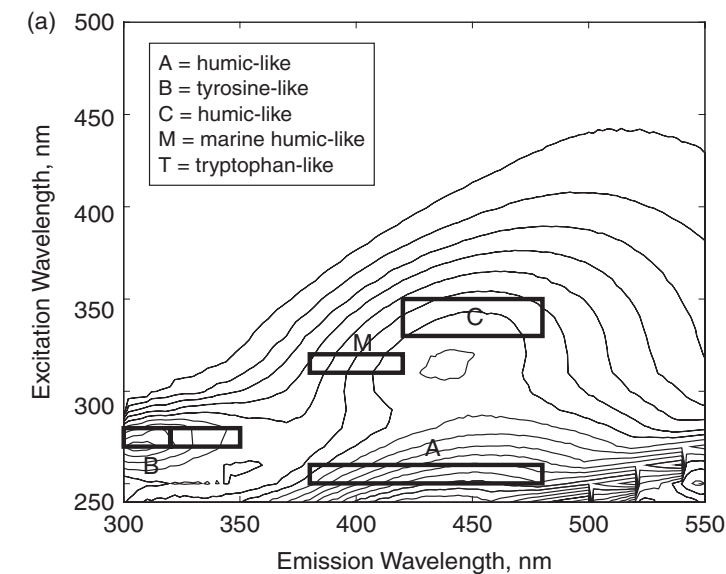
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Murphy et al. (2013). *Anal. Methods*, 5: 6557-6566

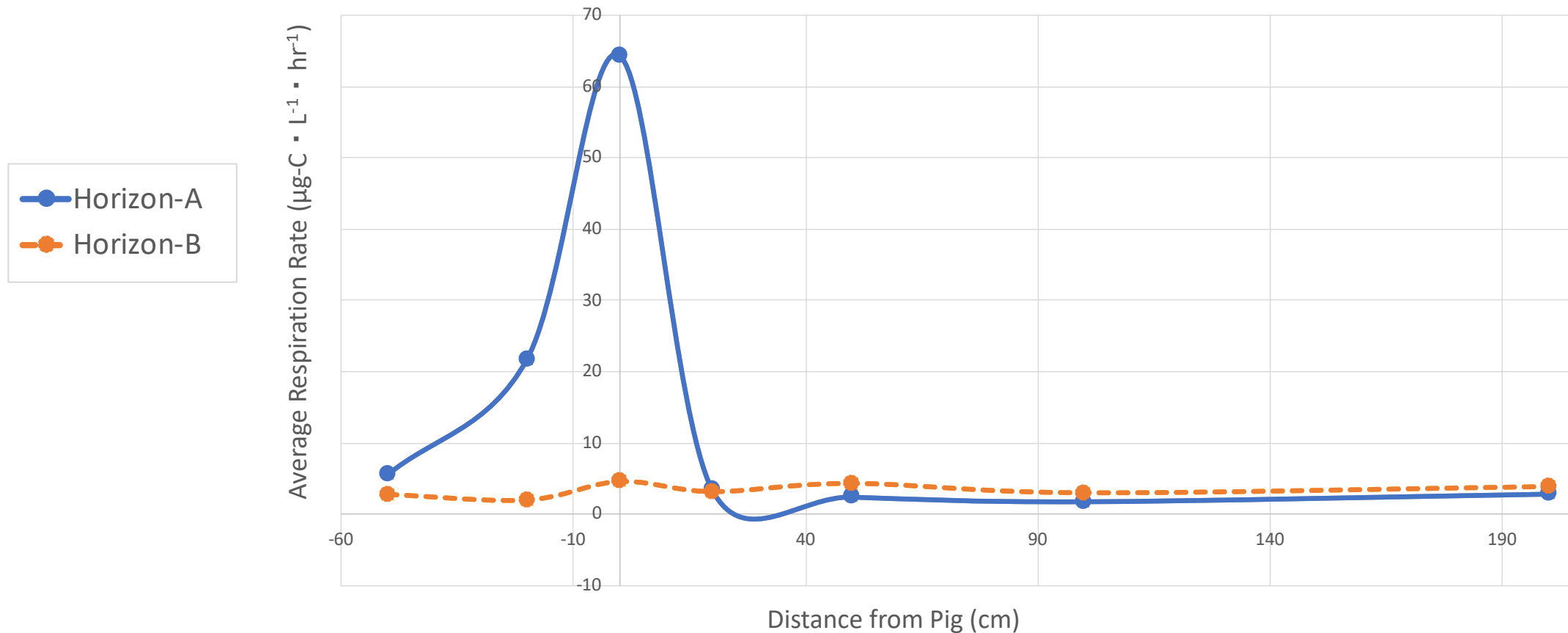


Preliminary Results

Summer

Bacterial Respiration

Summer 2019 - Average Lateral & Vertical Extent of Microbial Carbon Respiration

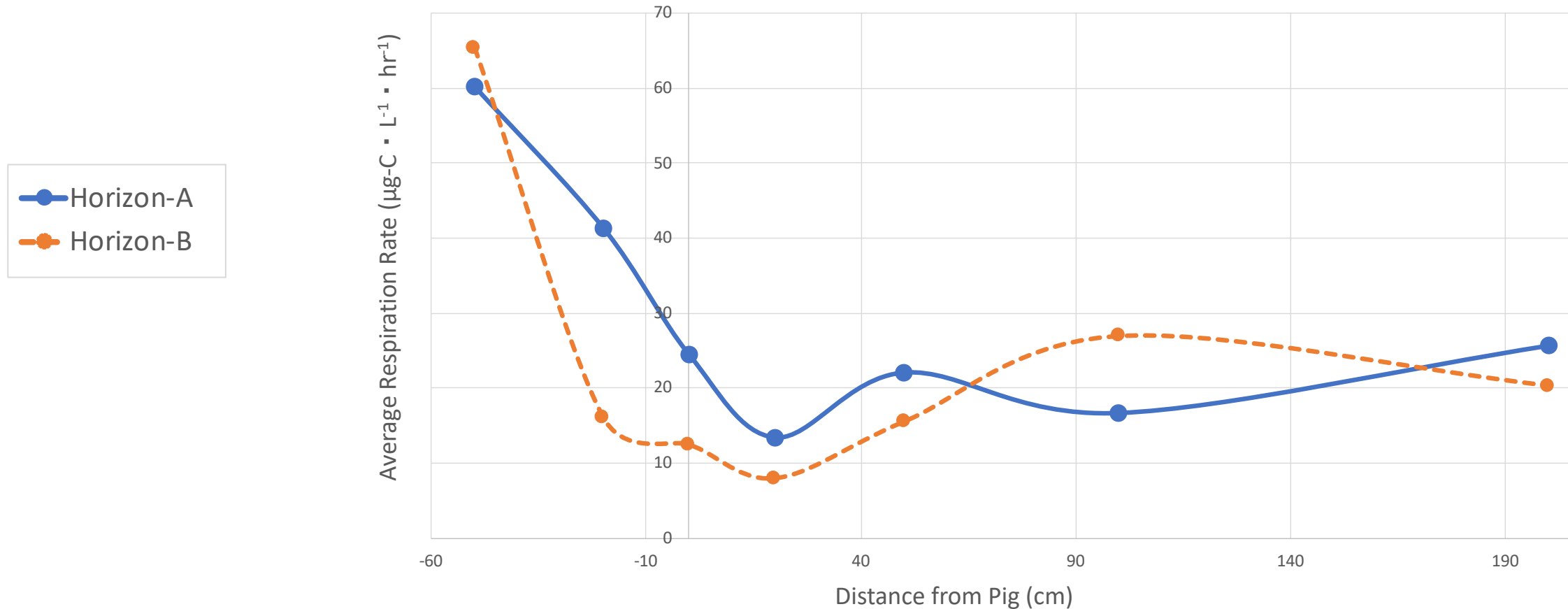


Preliminary Results

Fall

Bacterial Respiration

Fall 2019 - Average Lateral & Vertical Extent of Microbial Carbon Respiration

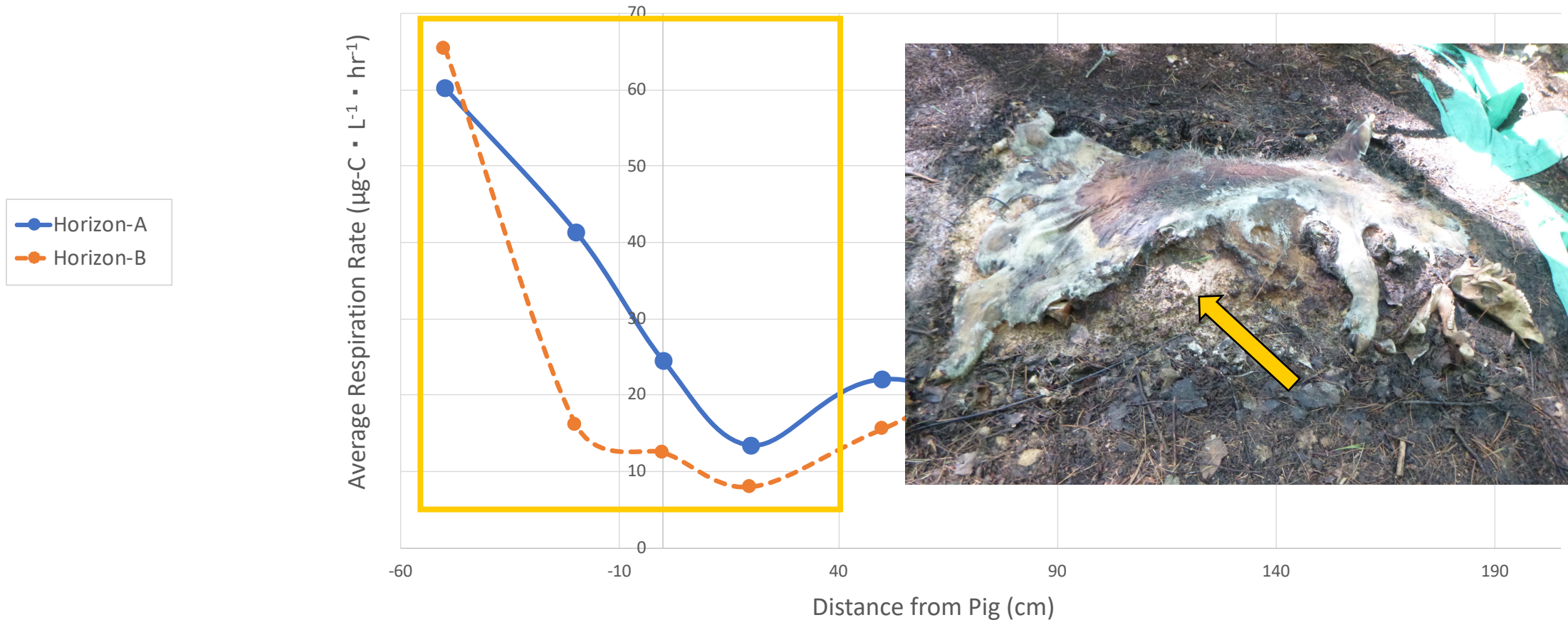


Preliminary Results

Fall

Bacterial Respiration

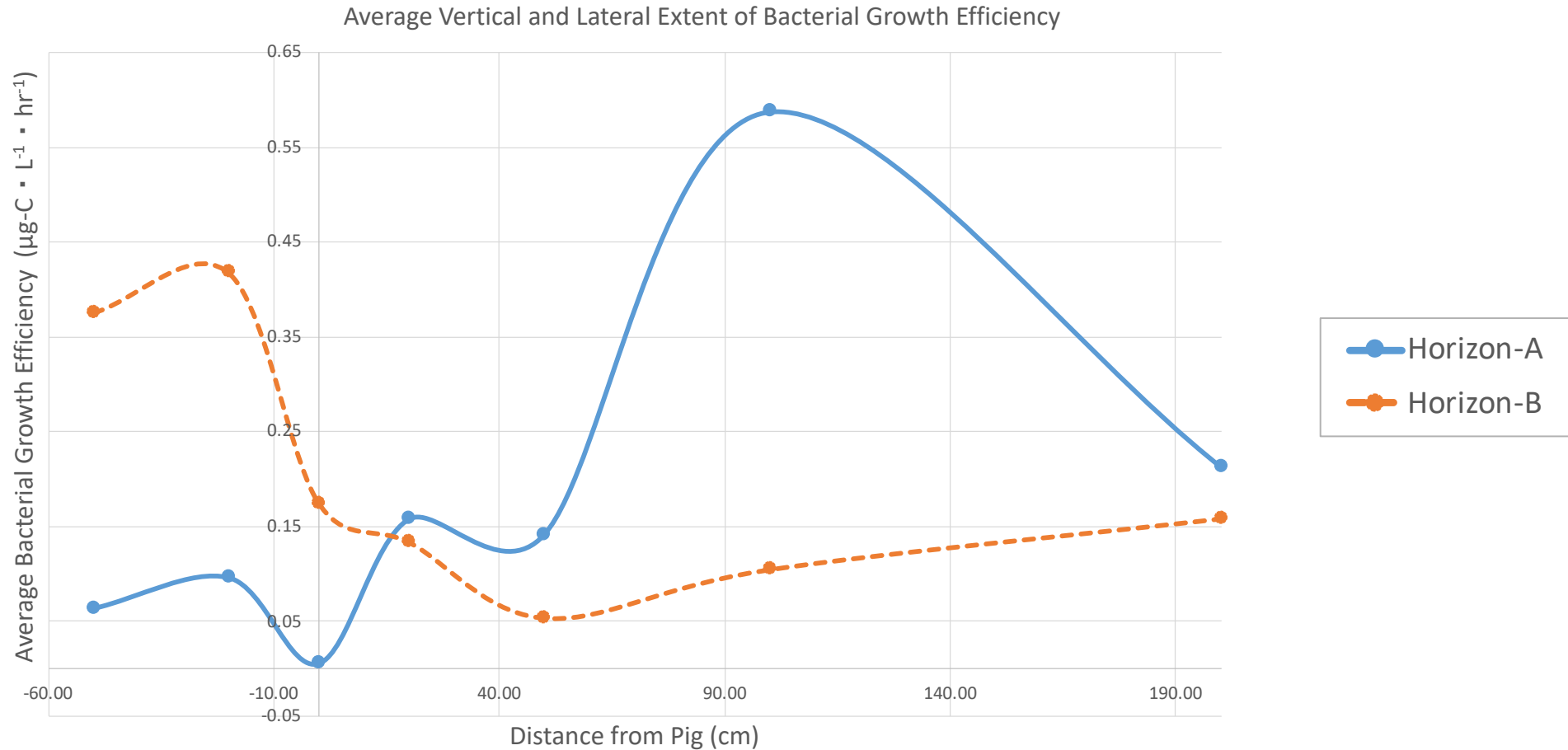
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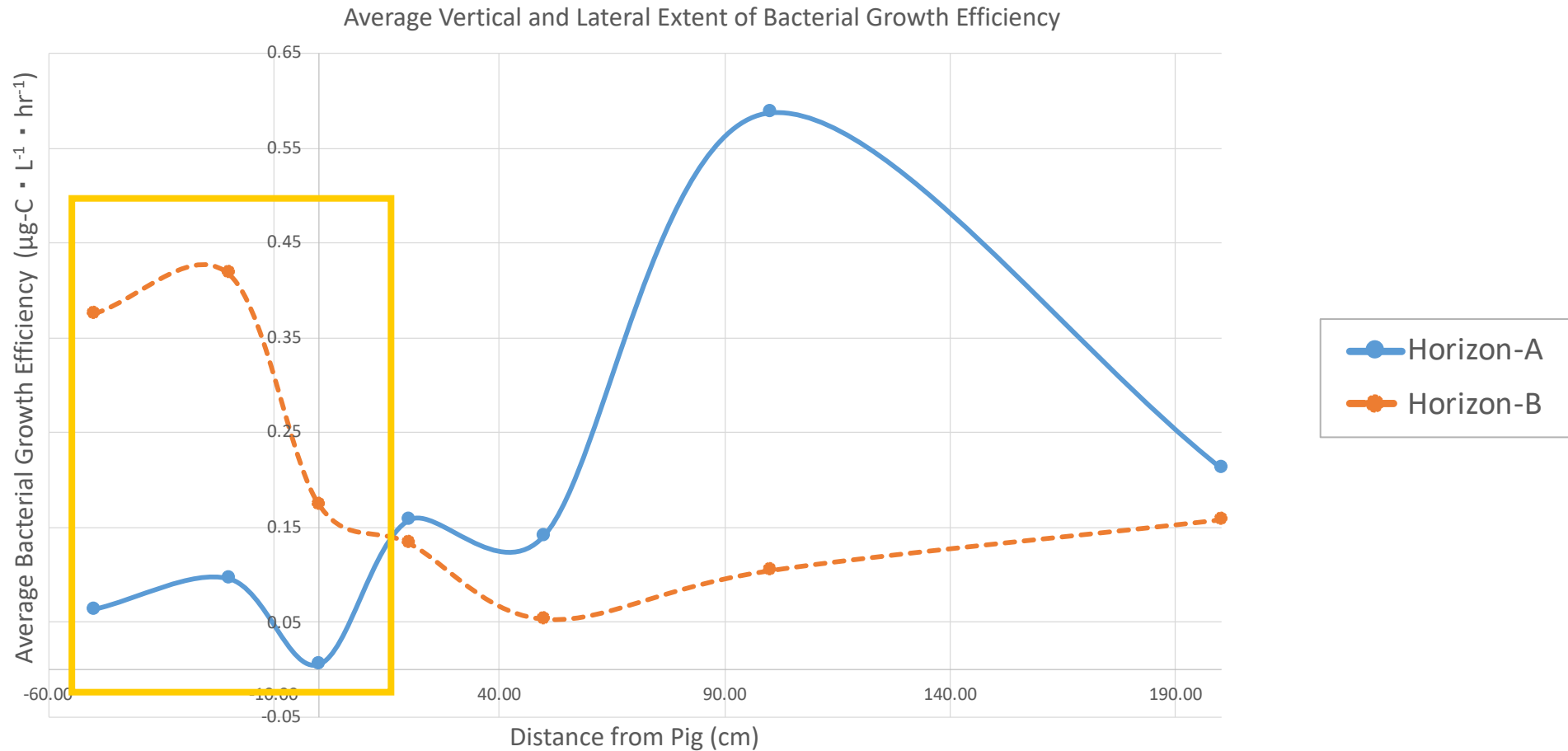
Preliminary Results

Summer

Bacterial Growth Efficiency

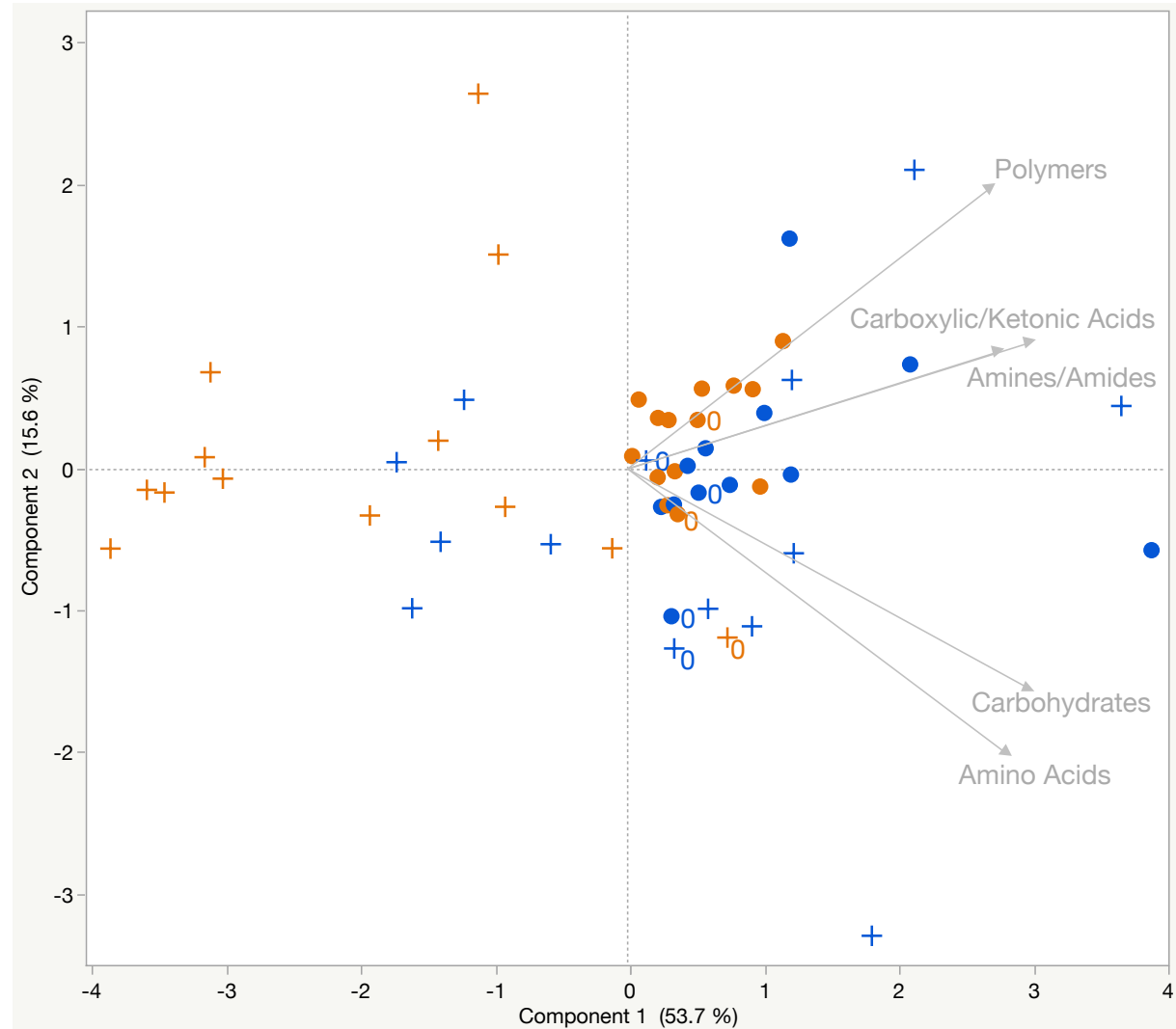


Bacterial Growth Efficiency



Metabolic Capacity

Summer (+)
Fall (●)
Horizon-A
Horizon-B



Preliminary Results

Summer & Fall

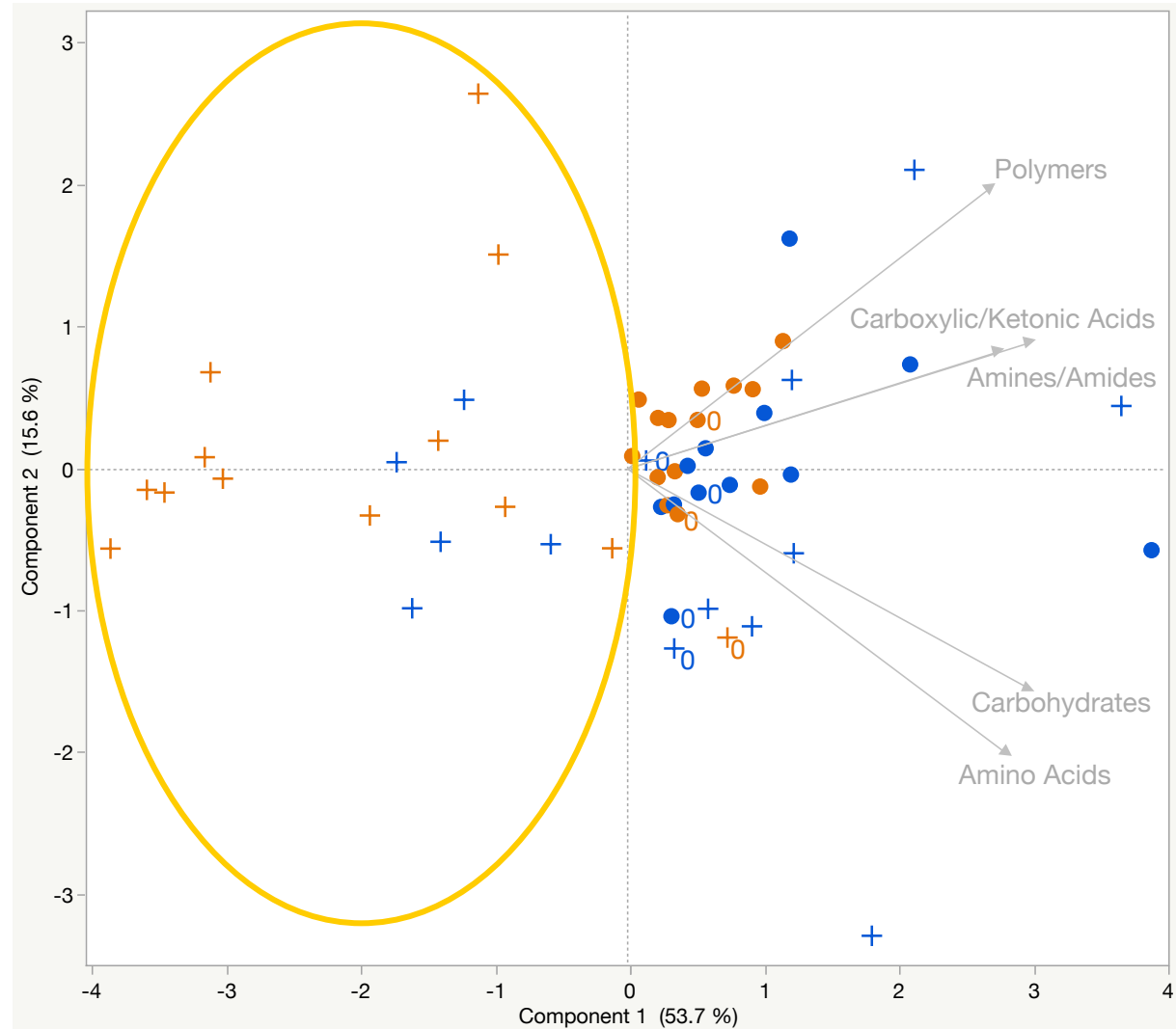
Metabolic Capacity

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Preliminary Results

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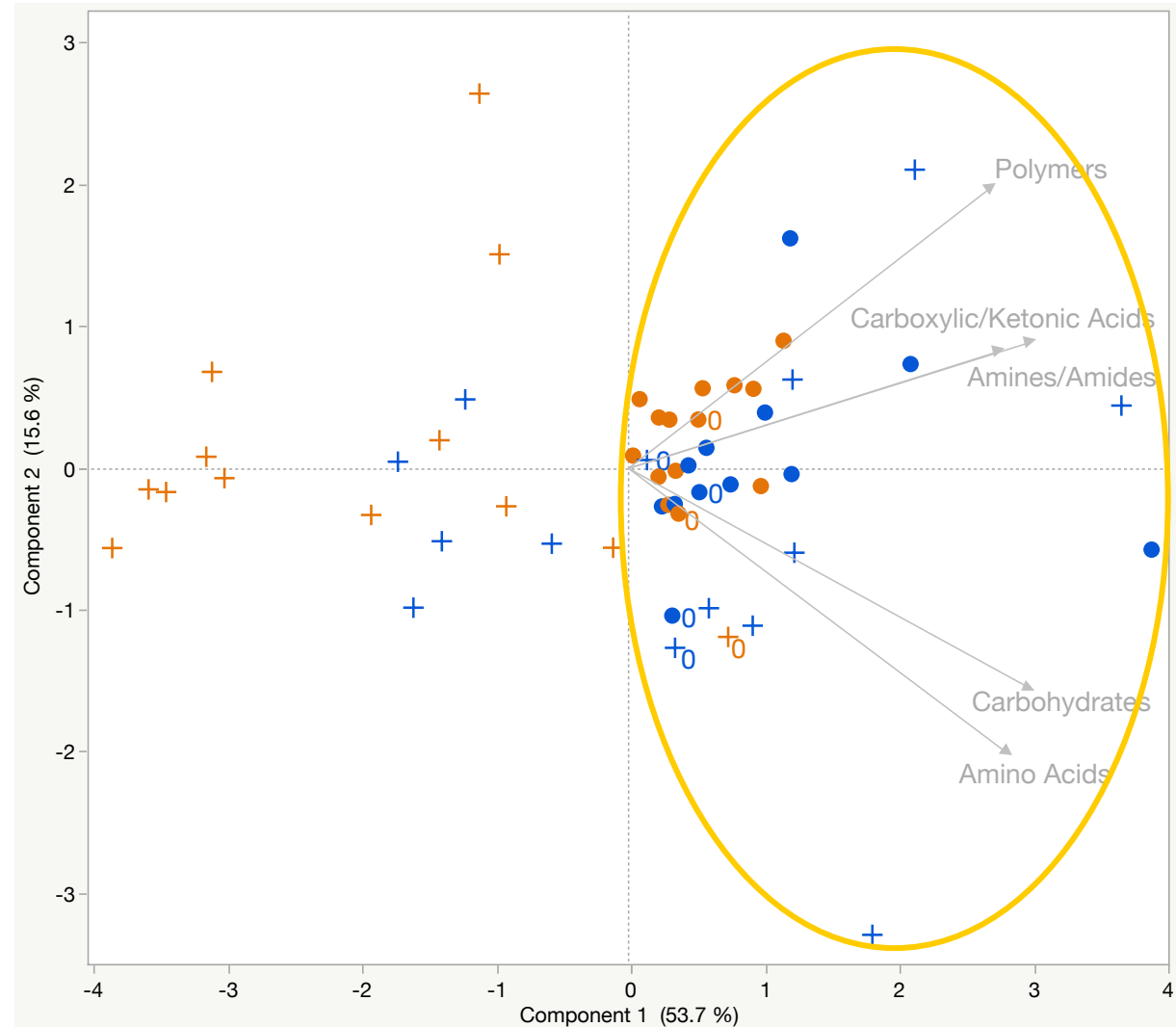
Metabolic Capacity

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Horizon-B

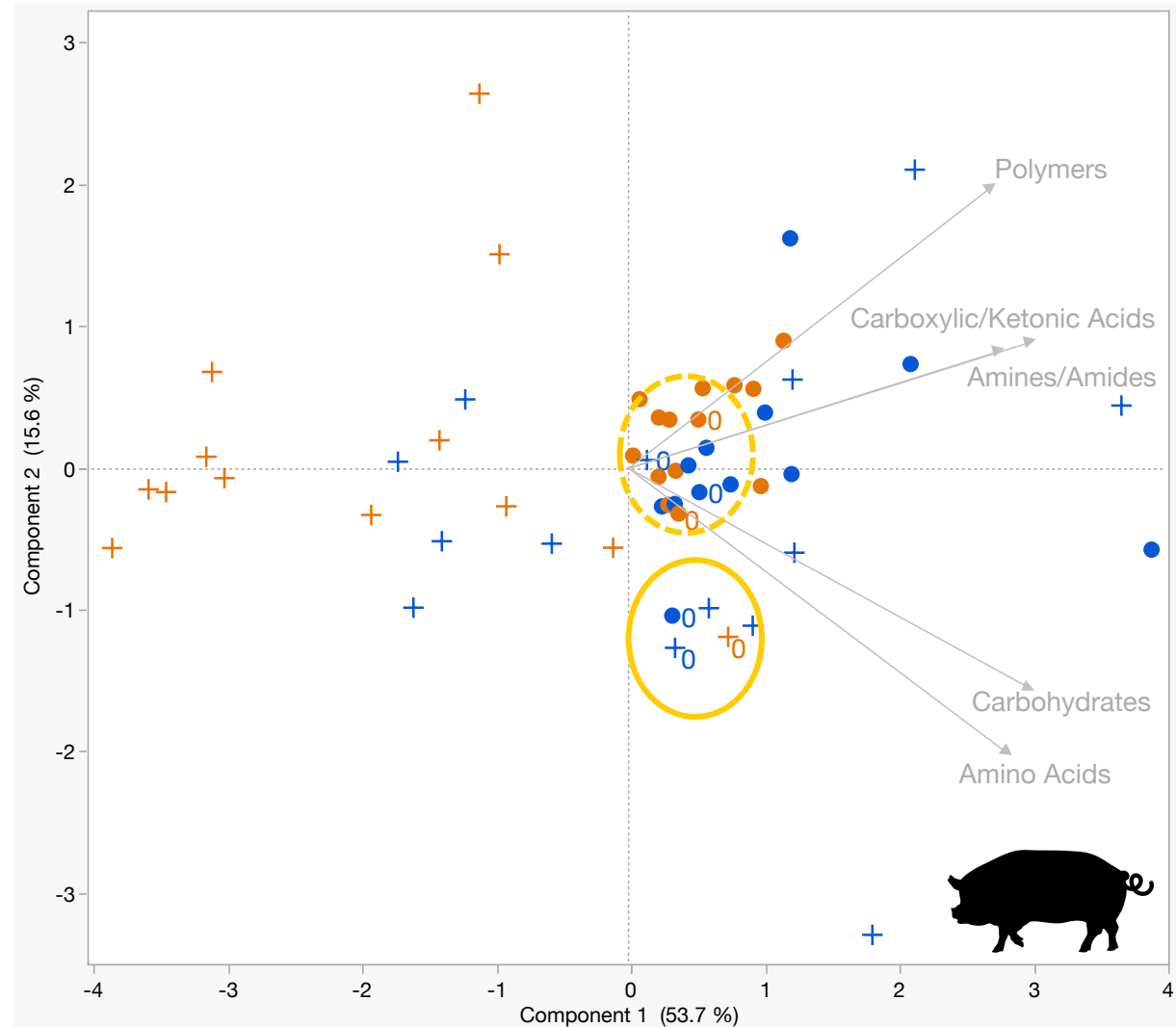


Preliminary Results

Summer & Fall

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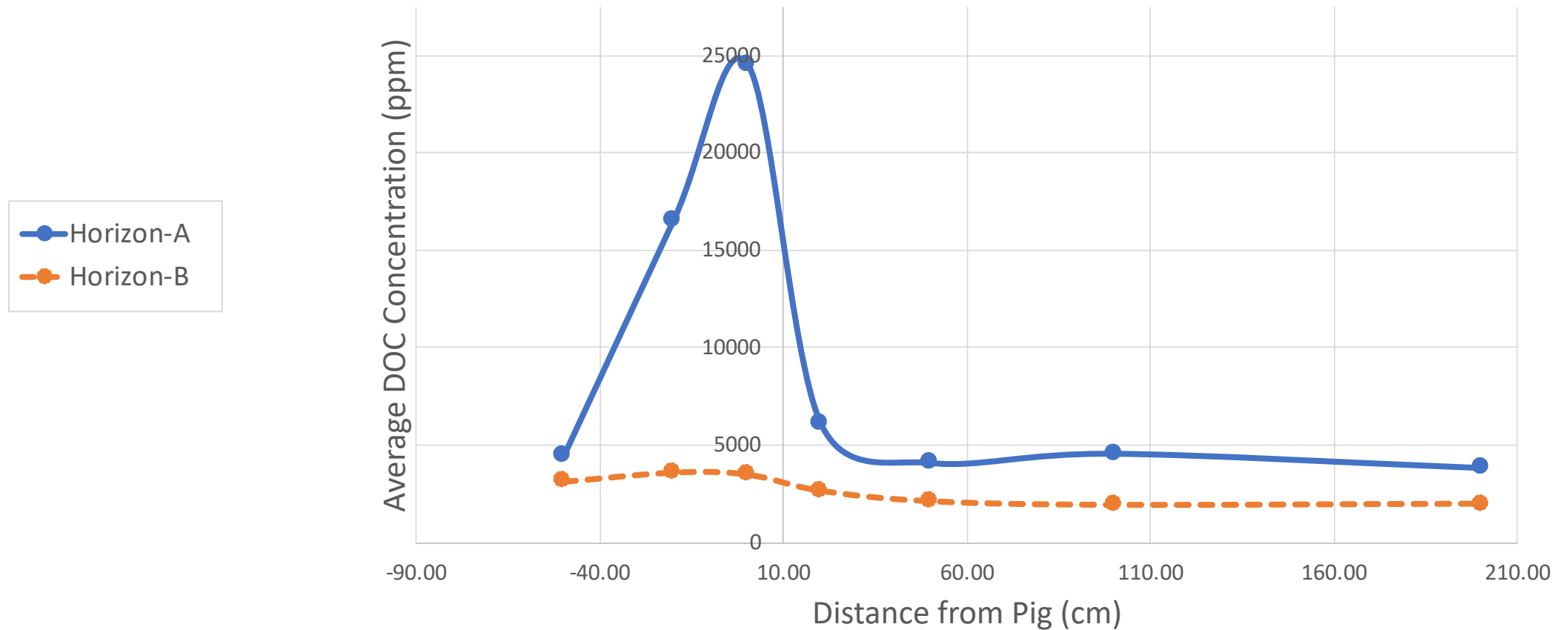


Preliminary Results

Summer

DOC Concentration

Average Lateral & Vertical Extent of DOC Concentration



Preliminary Results

DOC Characteristics (Fluorescence)

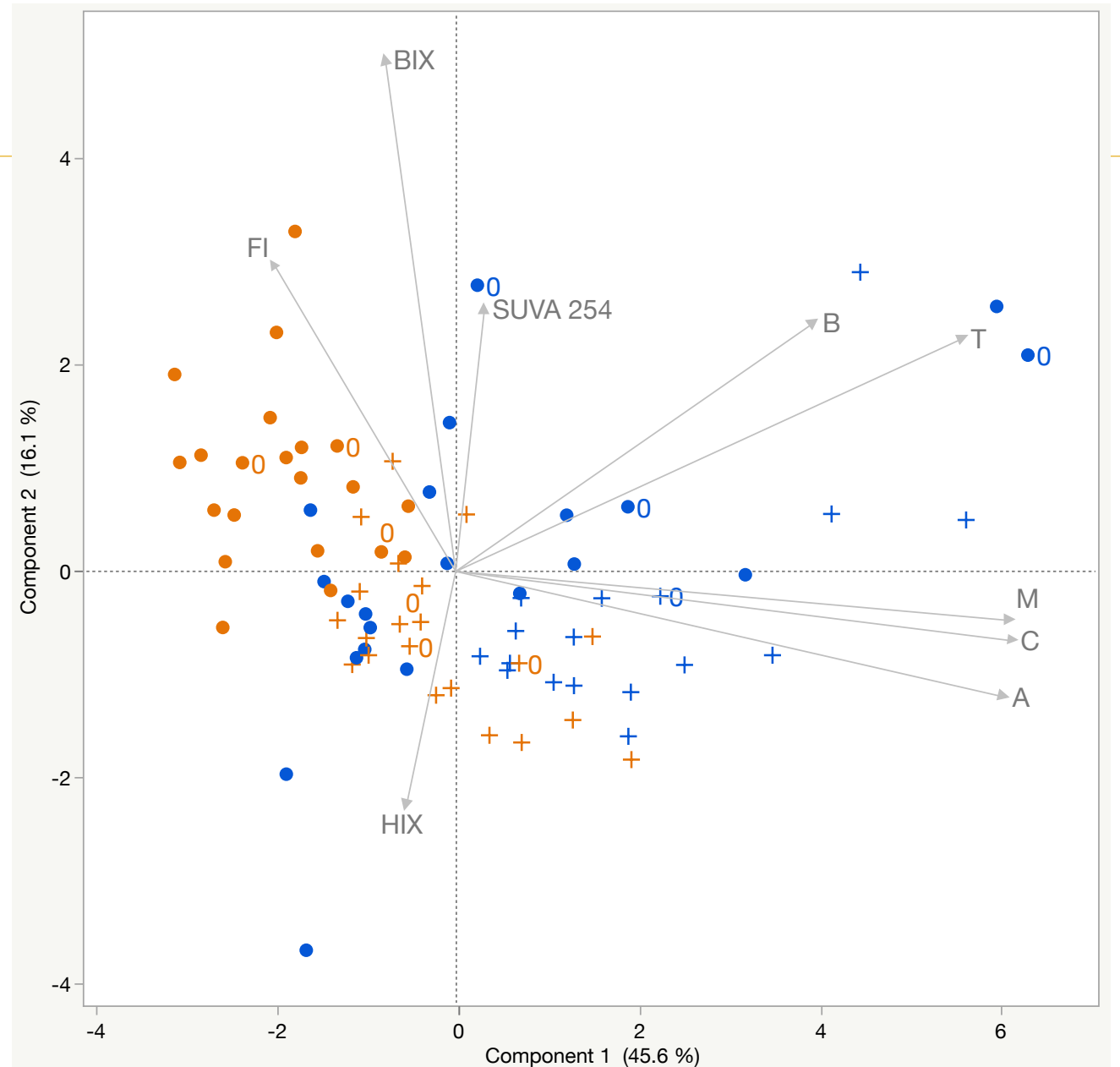
Summer (+)

Fall (●)

Horizon-A

Horizon-B

Index	Peak
FI – Source	A, C, M – Humic-like B, T – Protein-like
HIX – Humification	
BIX – Microbial / Fresh	
SUVA₂₅₄ - Aromaticity	



Preliminary Results

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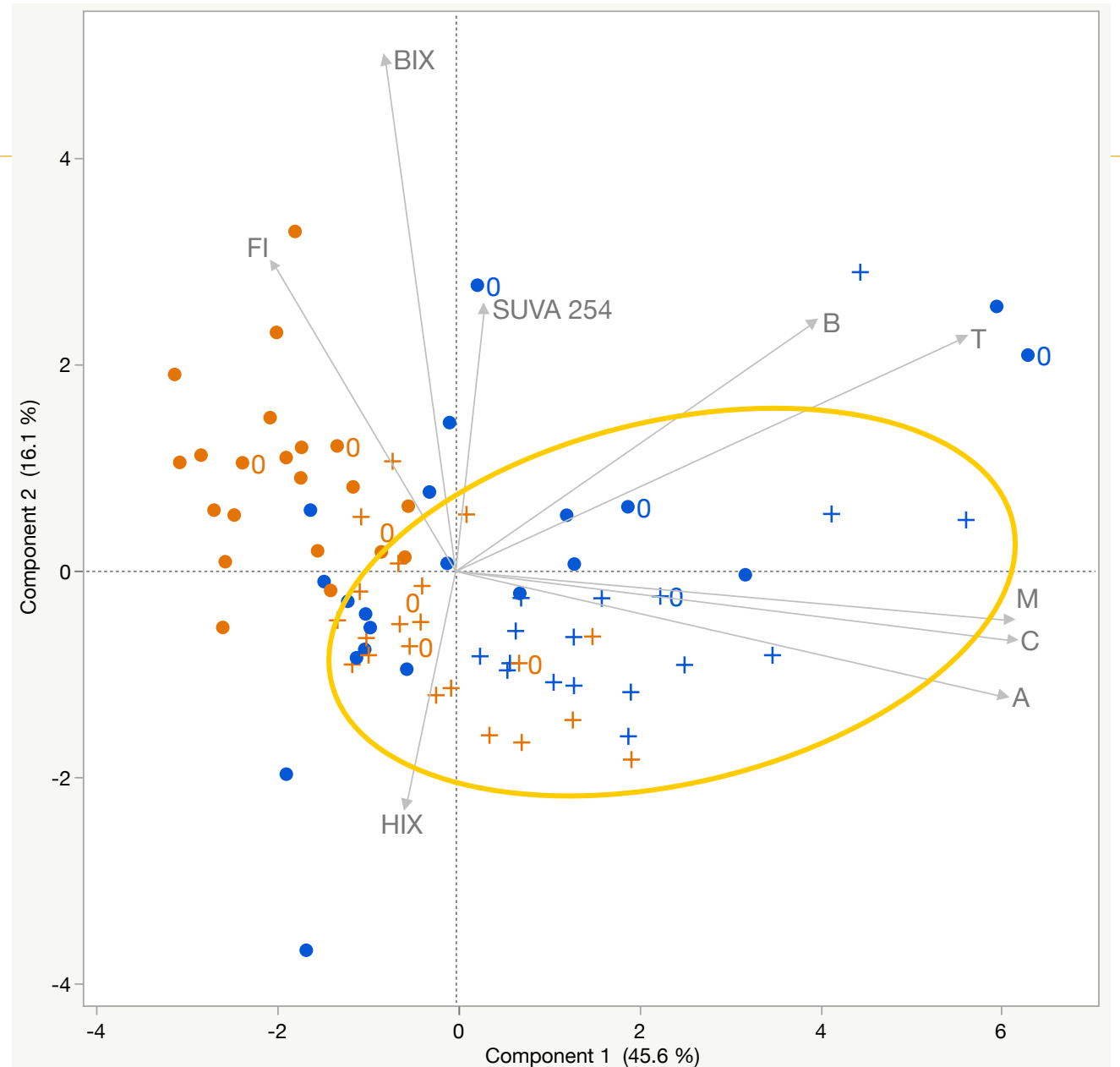
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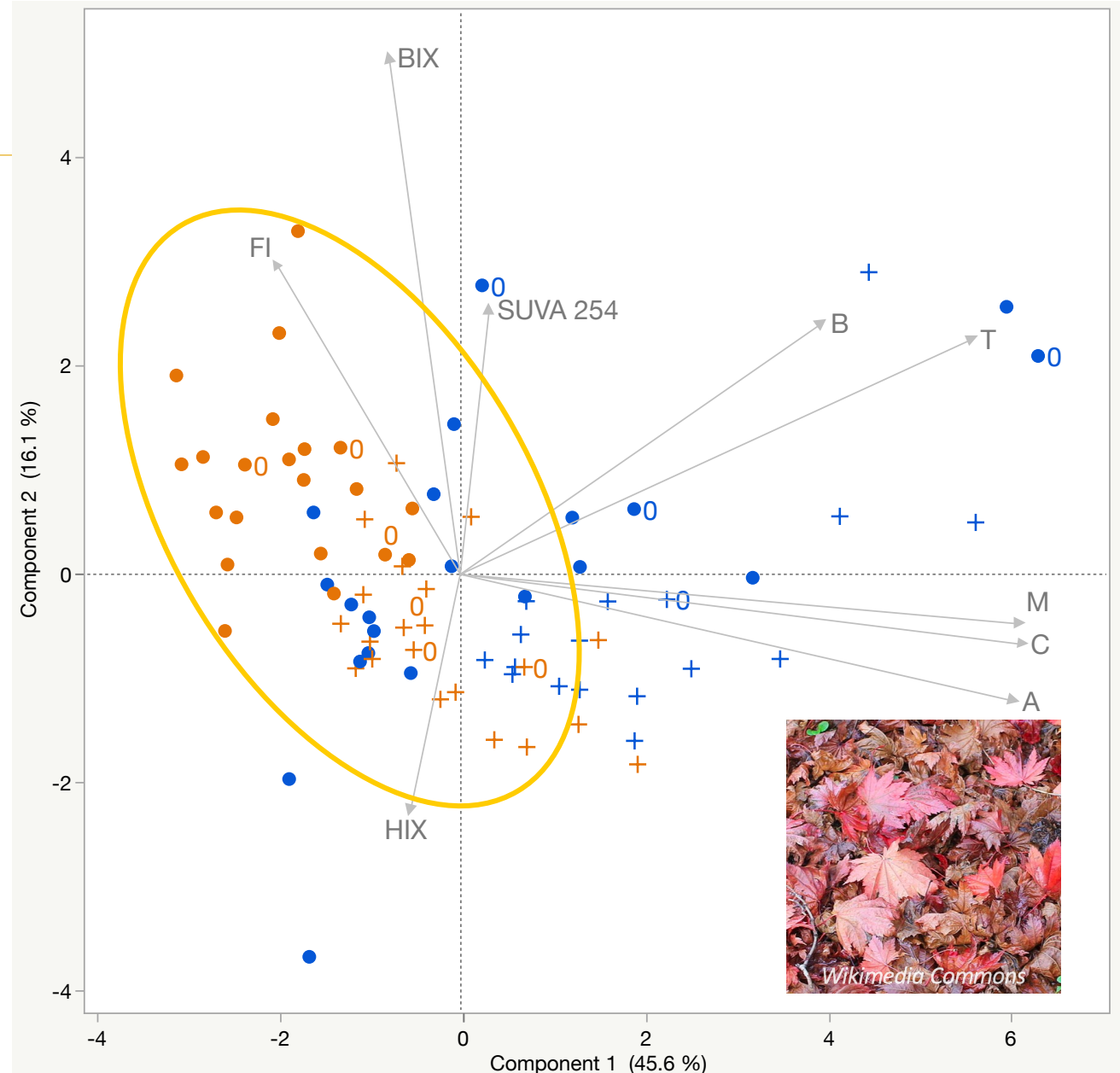
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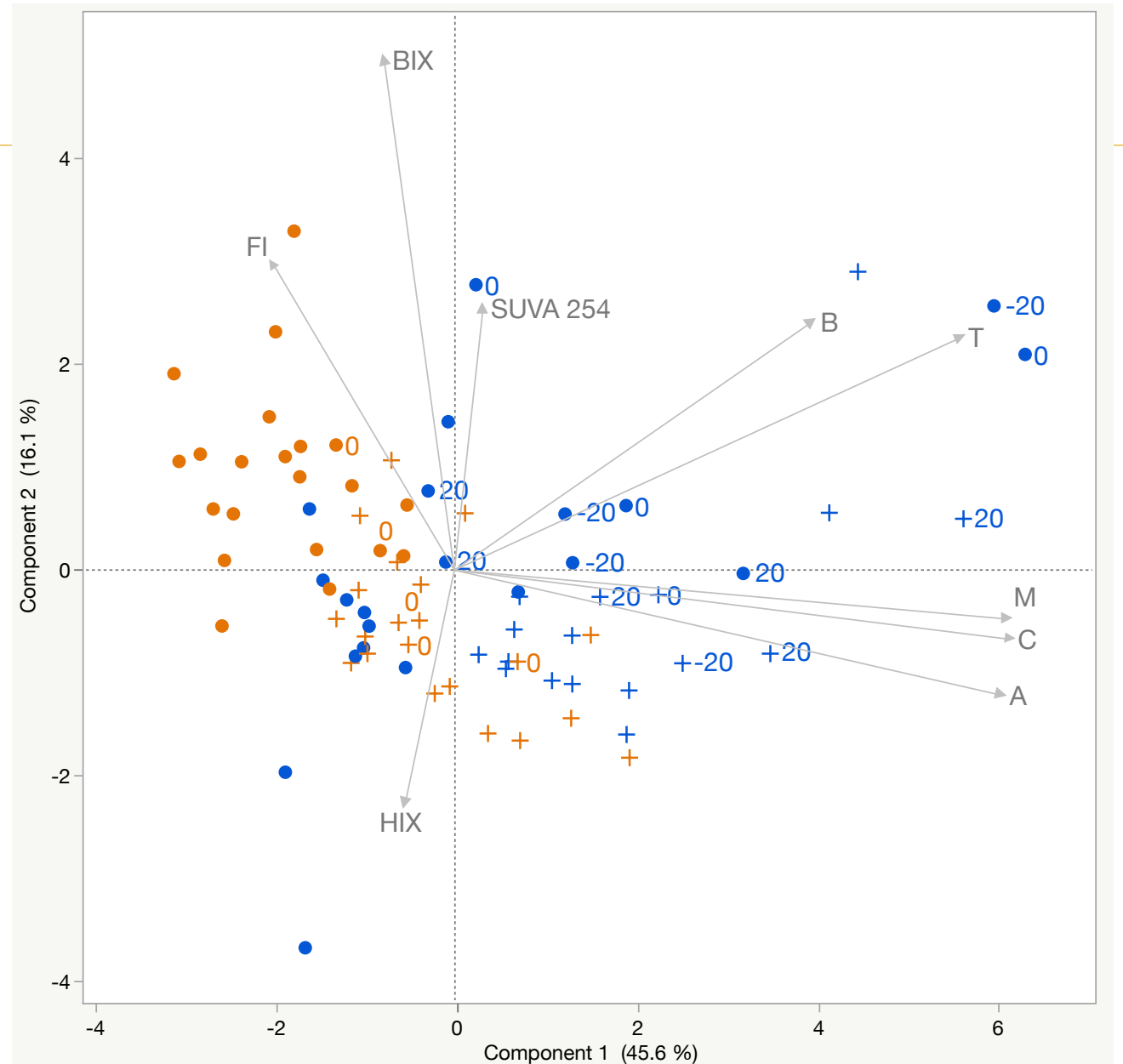
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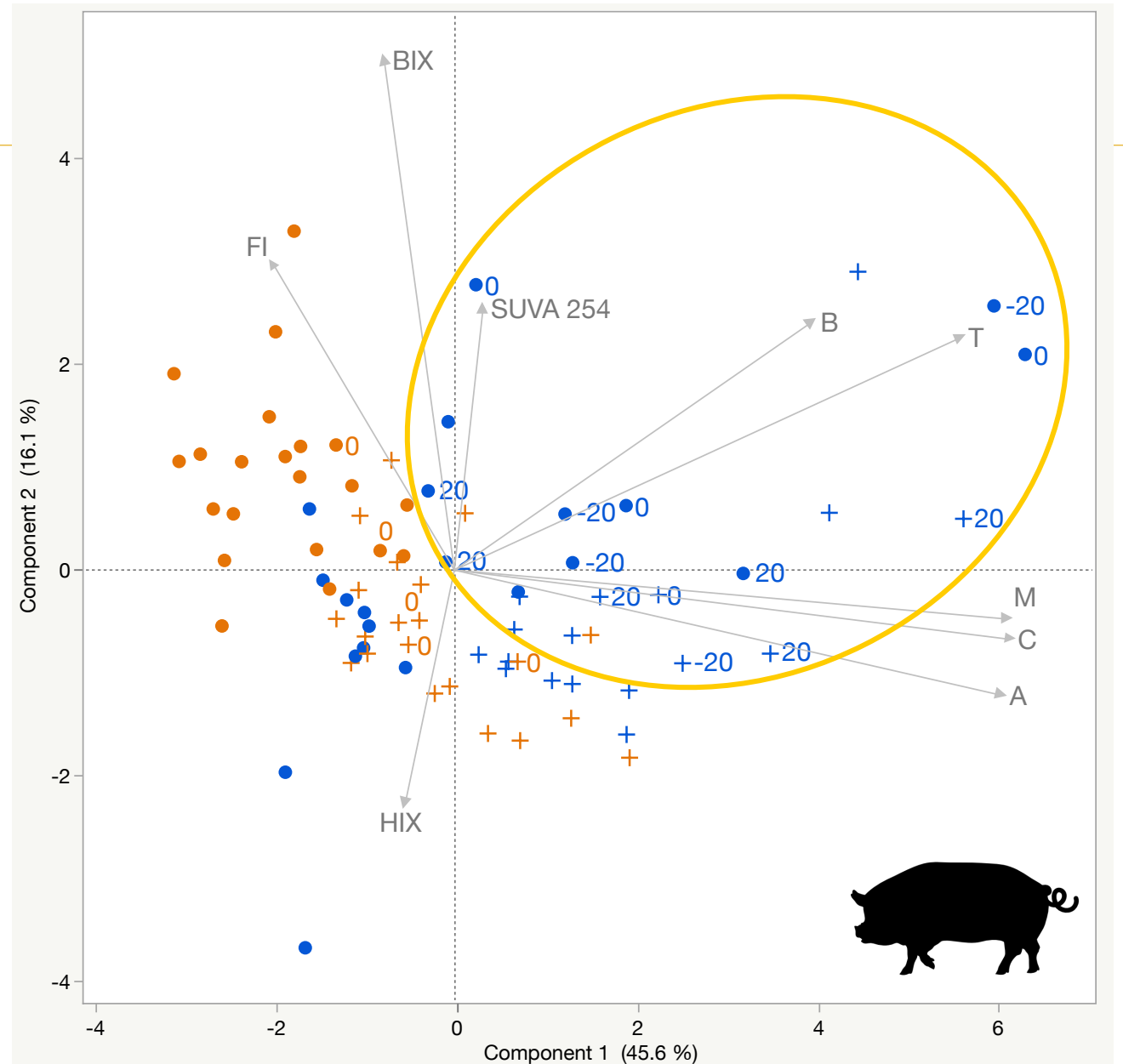
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Summary

Influence of carcass decomposition:

- Increased bacterial respiration
- Allocation of carbon towards energy production
- Shift in metabolic capacity; pattern resembles fall substrate degradation
- Shift in DOC source and composition of the A-horizon
- Effect of decomposition limited to the A-horizon and first 20cm laterally

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To do:

- Spring 2020 samples
- Regression / ANOVA
- Human trial & regional study



Applications

- Easier approbation process for future decomposition research facilities
- Mitigation of cross-contamination between donors
- Verify if decomposition facilities reflect a natural scenario
- Potential forensic techniques (PMI, Grave detection)



These projects and REST[ES] were made possible thanks to:

The generosity of our donors and their families



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