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Characterization of bacterial microbiomes present in cacao soils with cadmium in Cundinamarca-Colombia

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Grupo de investigación

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Introduction

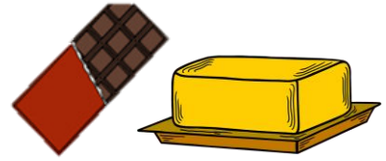
World production (2020-2021):
5,024 million/tons.

Country	Cdt in cacao beans (mg.kg-1)
Honduras	2,56
Ecuador	2,68
Perú	1,31
Costa Rica	2,20
Colombia	>3,0

Vanderschueren *et al.* (2021)

European Commission limits:

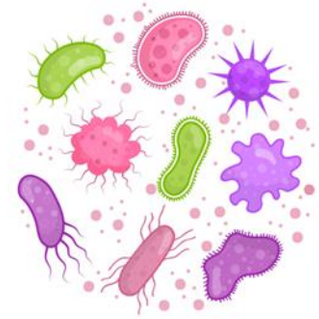
0,50- 1,1



0,10- 0,60

Haider *et al.* (2021)

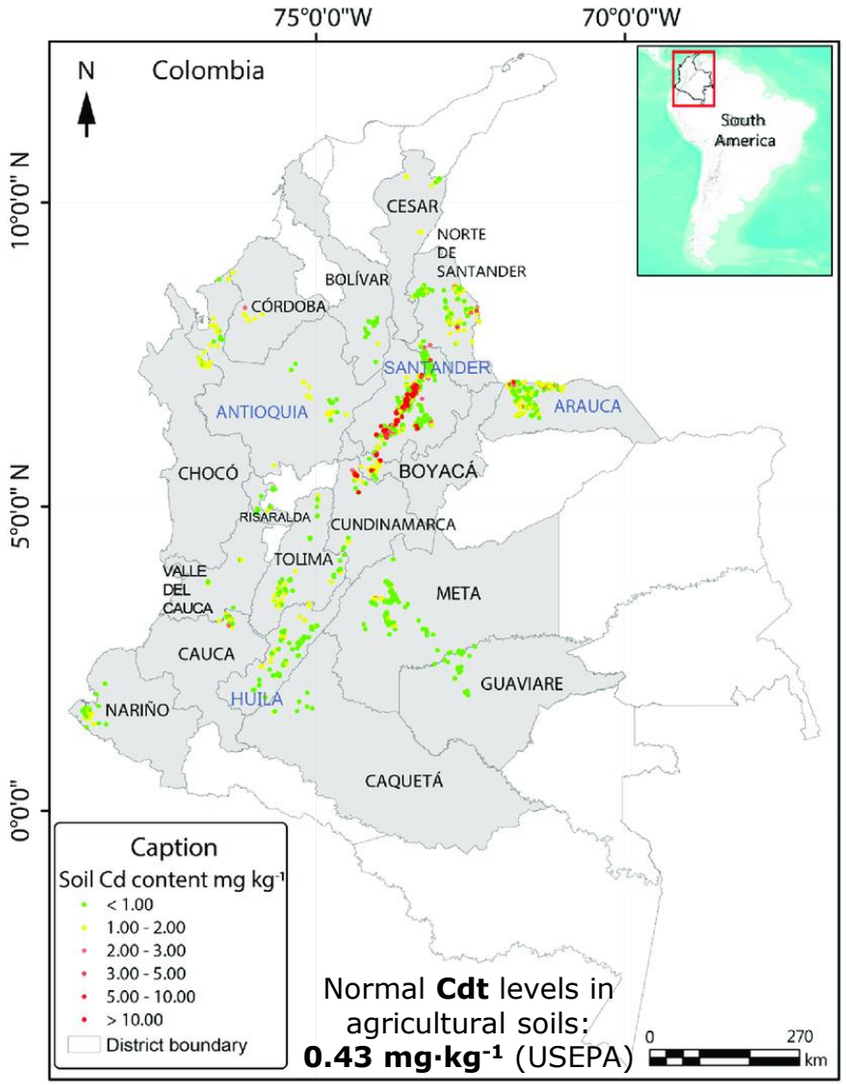
- Nutrient absorption
- Enzymatic activity
- Carbohydrate metabolism and antioxidants



- OM decomposition
- Biogeochemical cycle of C, N, P.

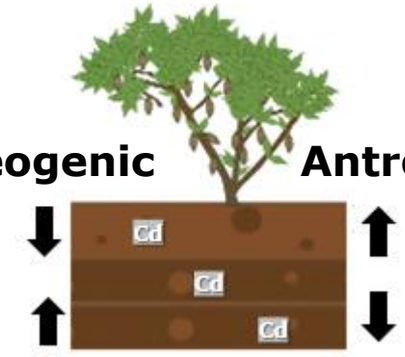
Wei *et al.* (2018)

Introduction



Normal **Cdt** levels in agricultural soils: **0.43 mg·kg^{-1}** (USEPA)

Origin of Cd in the soil



Vertical distribution of metal in the soil profile

RESEARCH QUESTION

Is the diversity of the bacterial community affected by the presence of high natural concentrations of Cd?

HYPOTHESIS

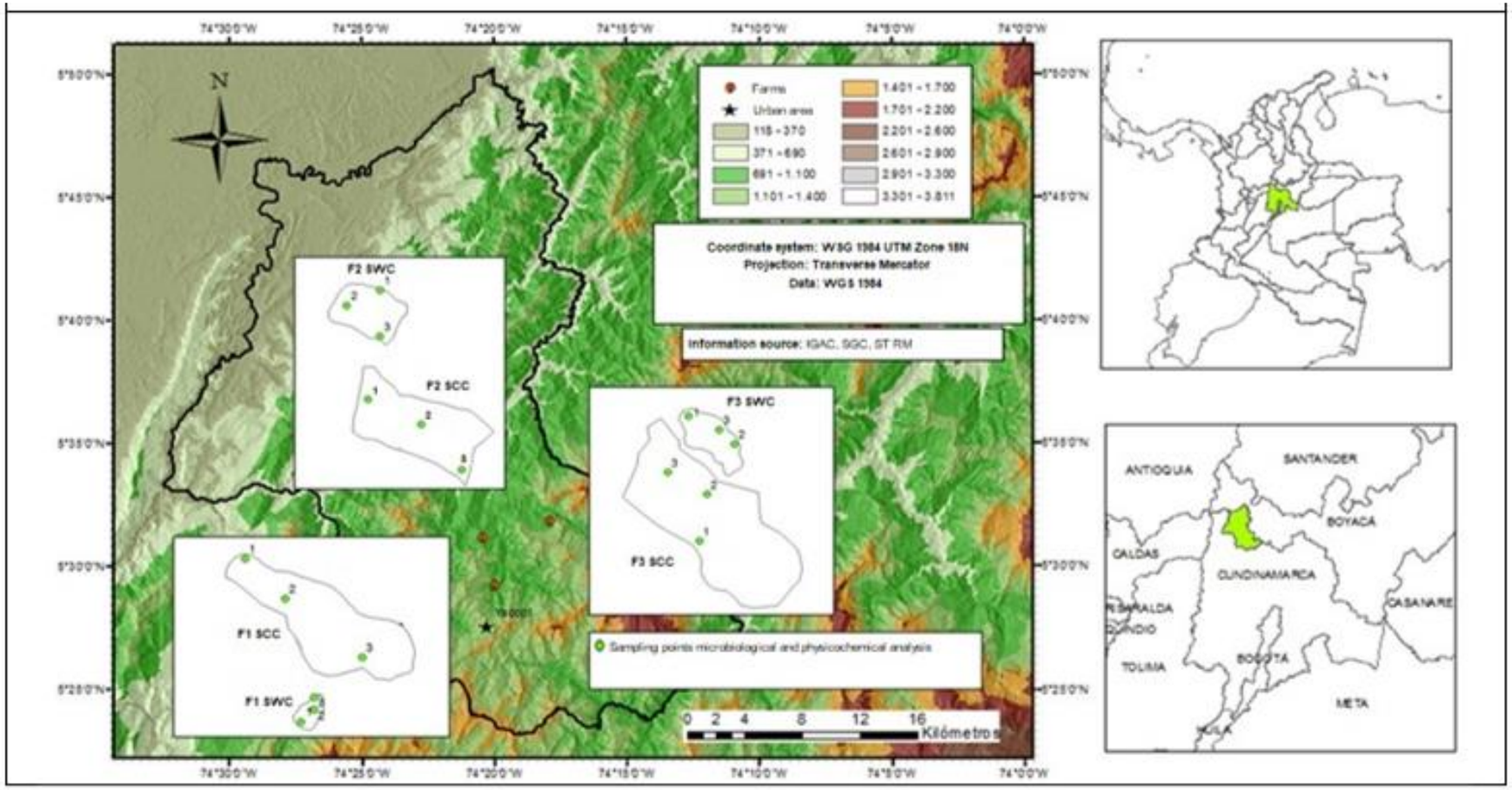
Natural Cd concentrations present in cacao soils exert selective pressure on the diversity of bacterial communities.

OBJECTIVE

To evaluate the effect of Cd on the diversity of bacterial communities present in cacao soils with different physicochemical properties and natural concentrations of Cd.

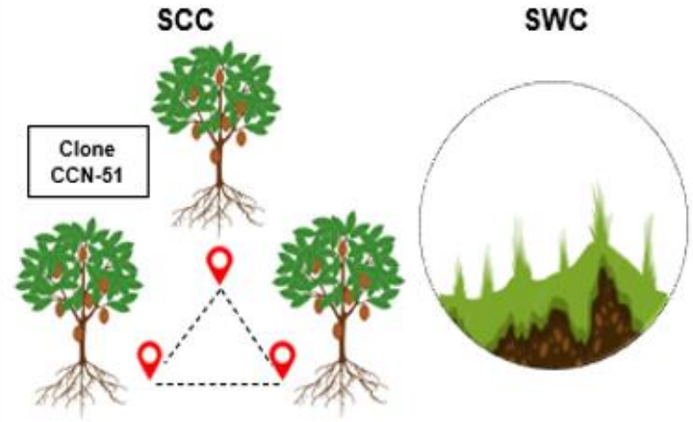
Materials and methods

Study location



Rodríguez-Albaracn *et al.* (2019)

Sampling points



Type of sample

Rz (n:6)
0-30 cm — D1 (n:18)
31-100 cm — D2 (n:12)

Total samples: 36

Materials and methods

Physicochemical analysis of soils and Cd determination

Variable	Method
Clays	Bouyoucos
pH	Suspension soil: water (weight:volume ratio 1:1)
CO	Walkley & Black
Ca, Mg, Na, K	Ammonium acetate 1M pH 7.0
CICE	Displacement of NH4 exchanged with NaCl
Mn, Fe, Zn, Cu	Extraction with DTPA
B	Extraction with monocalcium phosphate
P	Bray II
Cdt	Extraction with aqua regia (HCl:HNO3–3:1)
Cdd	

Rodriguez-Albaracn *et al.* (2019)

Metataxonomic library preparation and sequencing

DNA extraction

DNeasy
Qubit 2.0
Electroforesis

PCR amplification V4 16S rRNA

Faith *et al.* (2013)

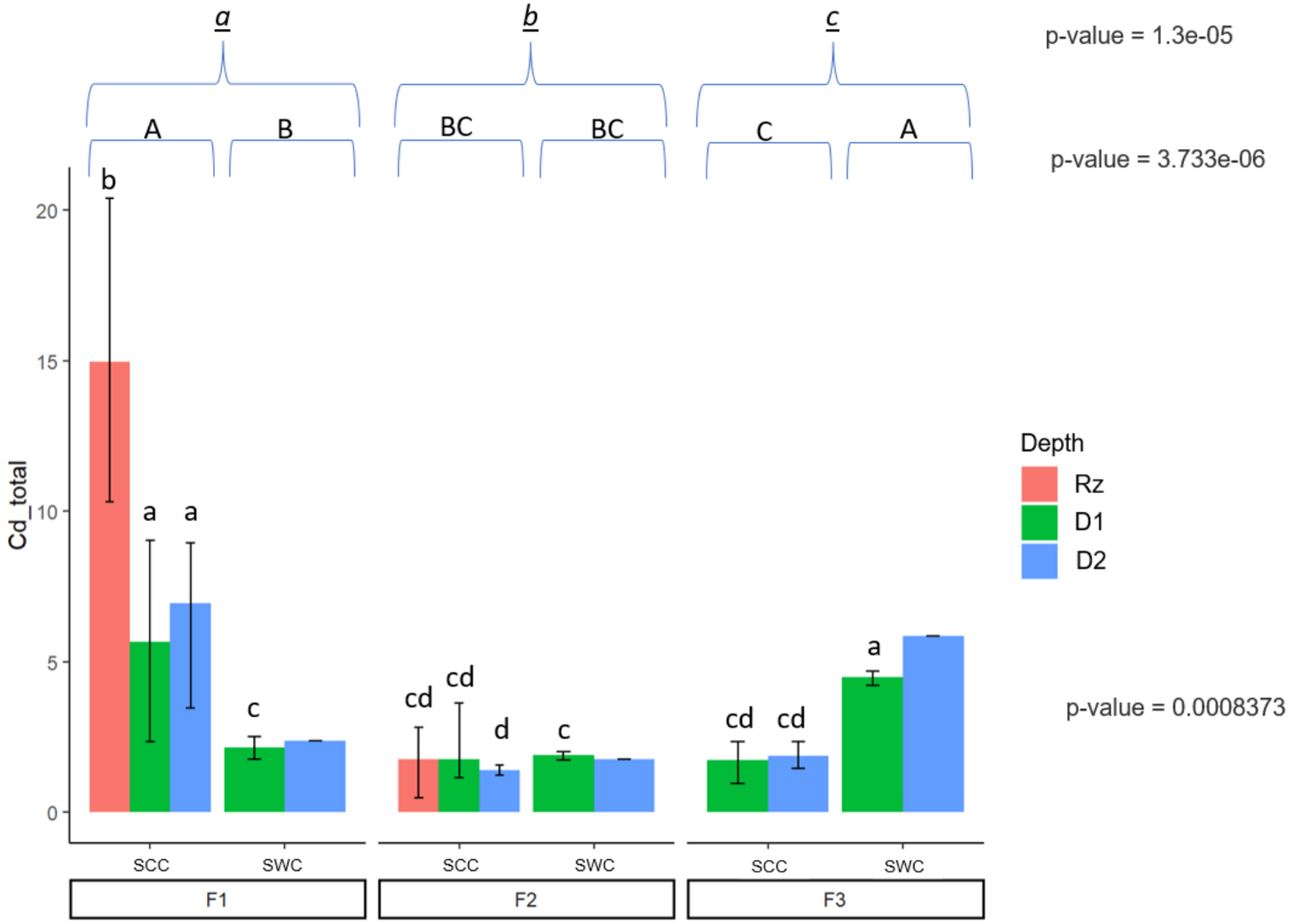
Sequencing

Illumina
Miseq
Kit V3

Data processing

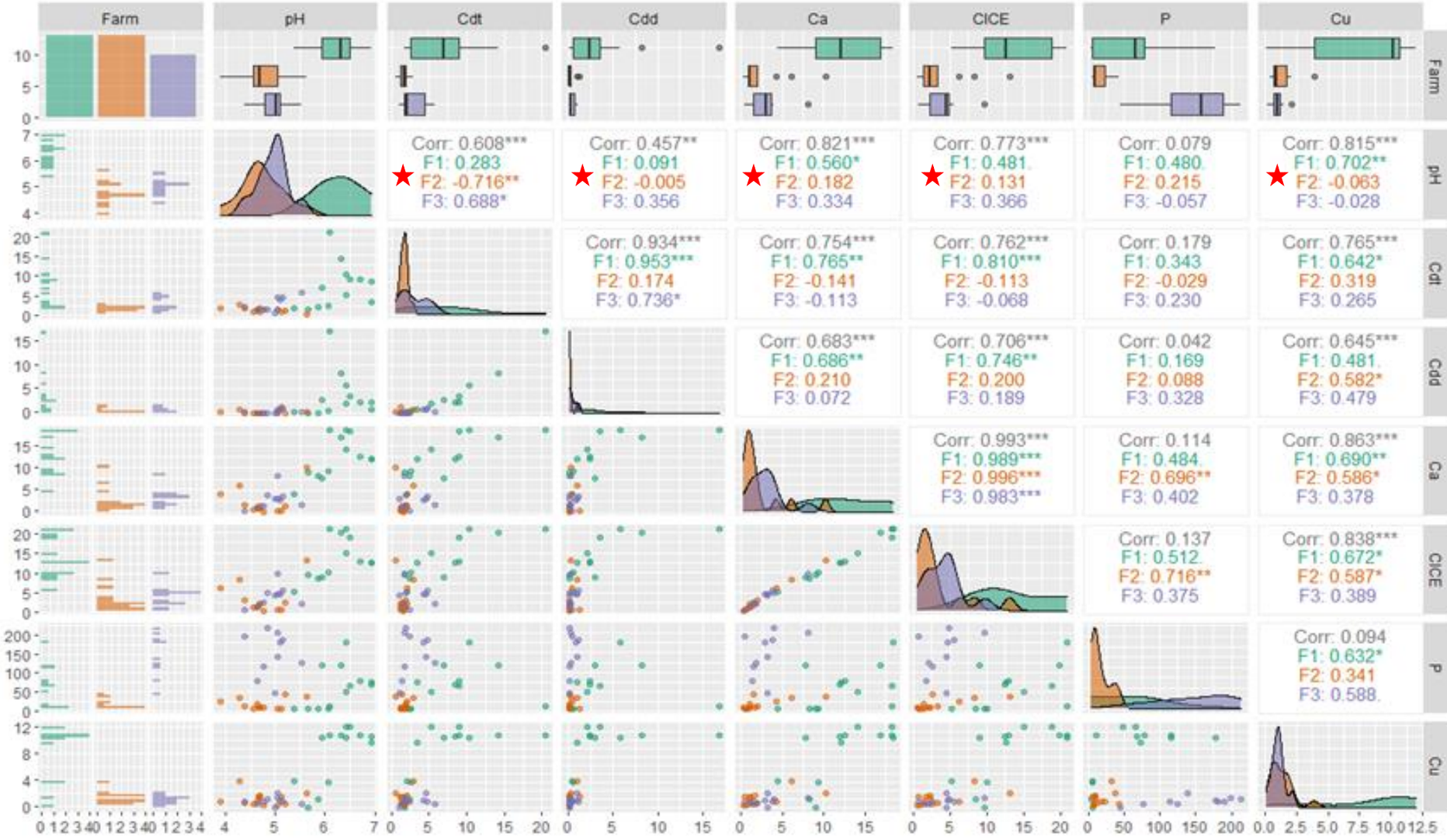
FastQC
MultiQC
Trimmomatic
Sickle
Micro. Analyst
R Studio

Results: Physicochemical analysis of soils and concentration of Cdt and Cdd



The concentrations of Cd total (Cdt) in the three farms were variable and higher than the levels established for agricultural soils.

Results

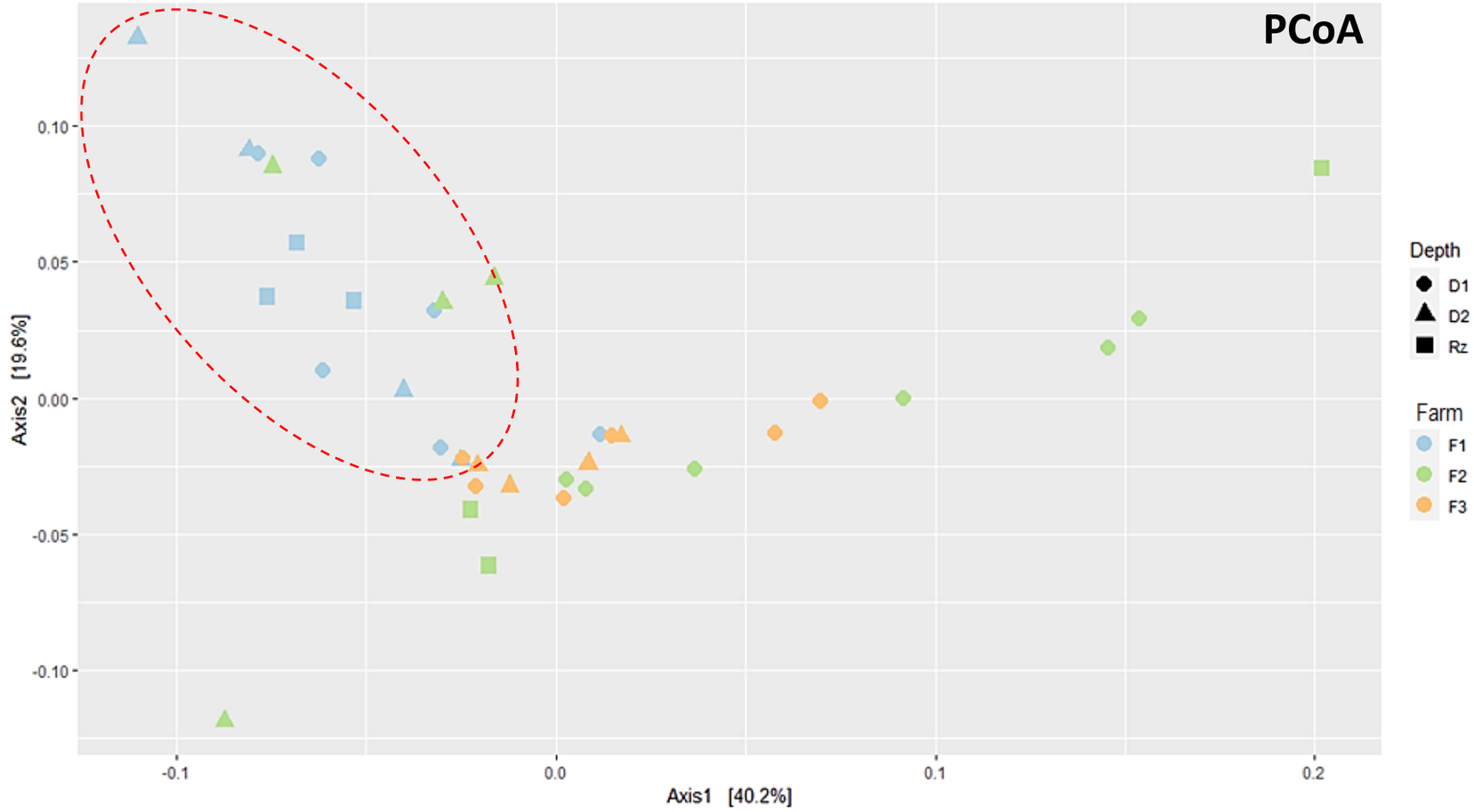


Cdt was positively correlated with Cd available (Cdd), **pH**, Ca, CICE and CU.

Results: Bacterial diversity in soils

Index	F1	F2	F3
Chao1	970	909	1066
Shannon	5,79	5,64	6,21
Gini-Simpson	0,97	0,98	0,97

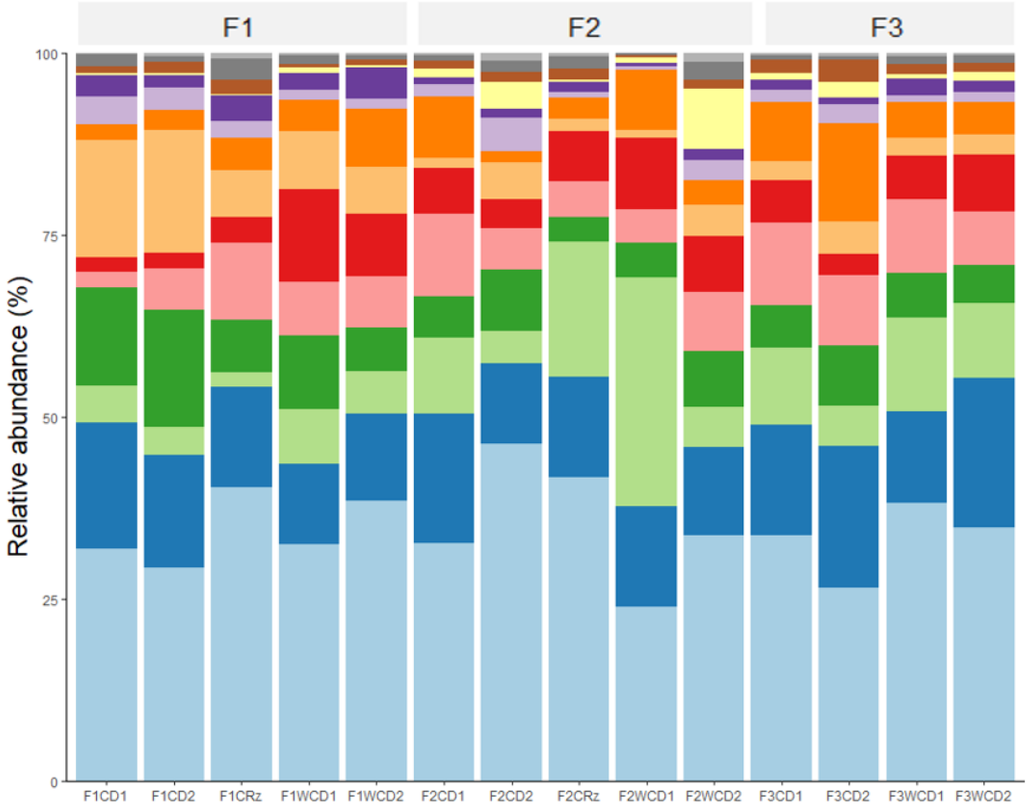
- The alpha diversity index indicates highly diverse communities.
- The samples were separated by farm (PCoA).



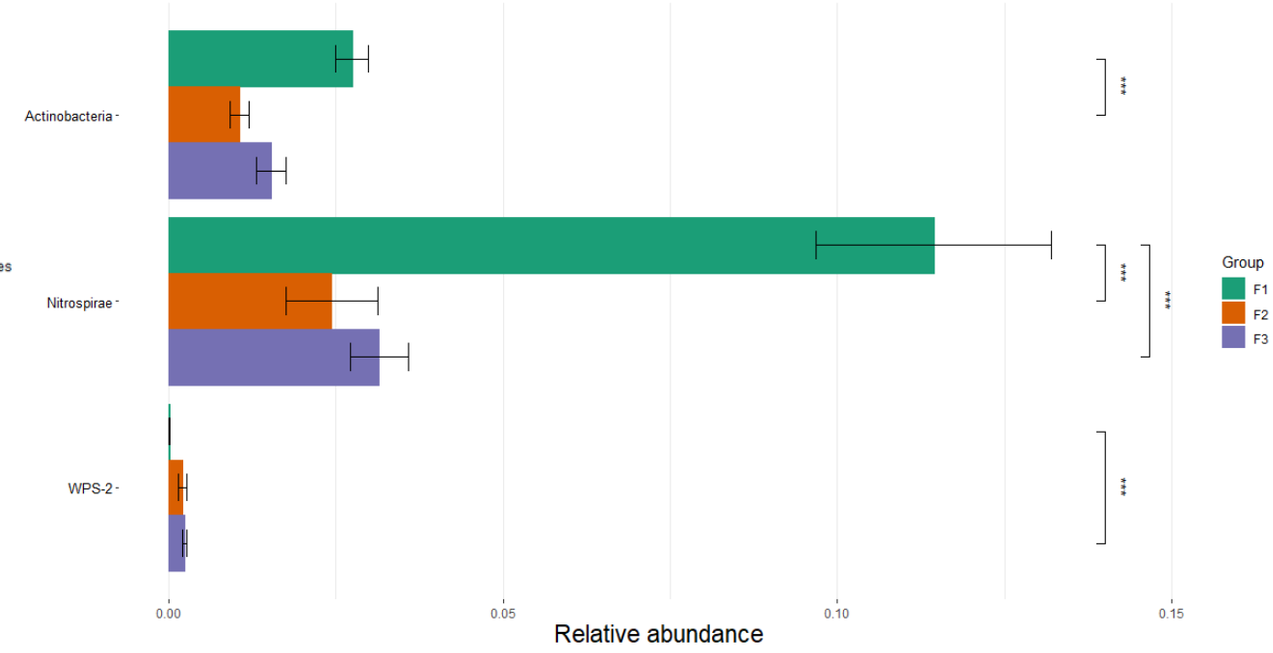
[PERMANOVA] P-Value: 0.001

Results: Bacterial diversity in soils

Relative abundance

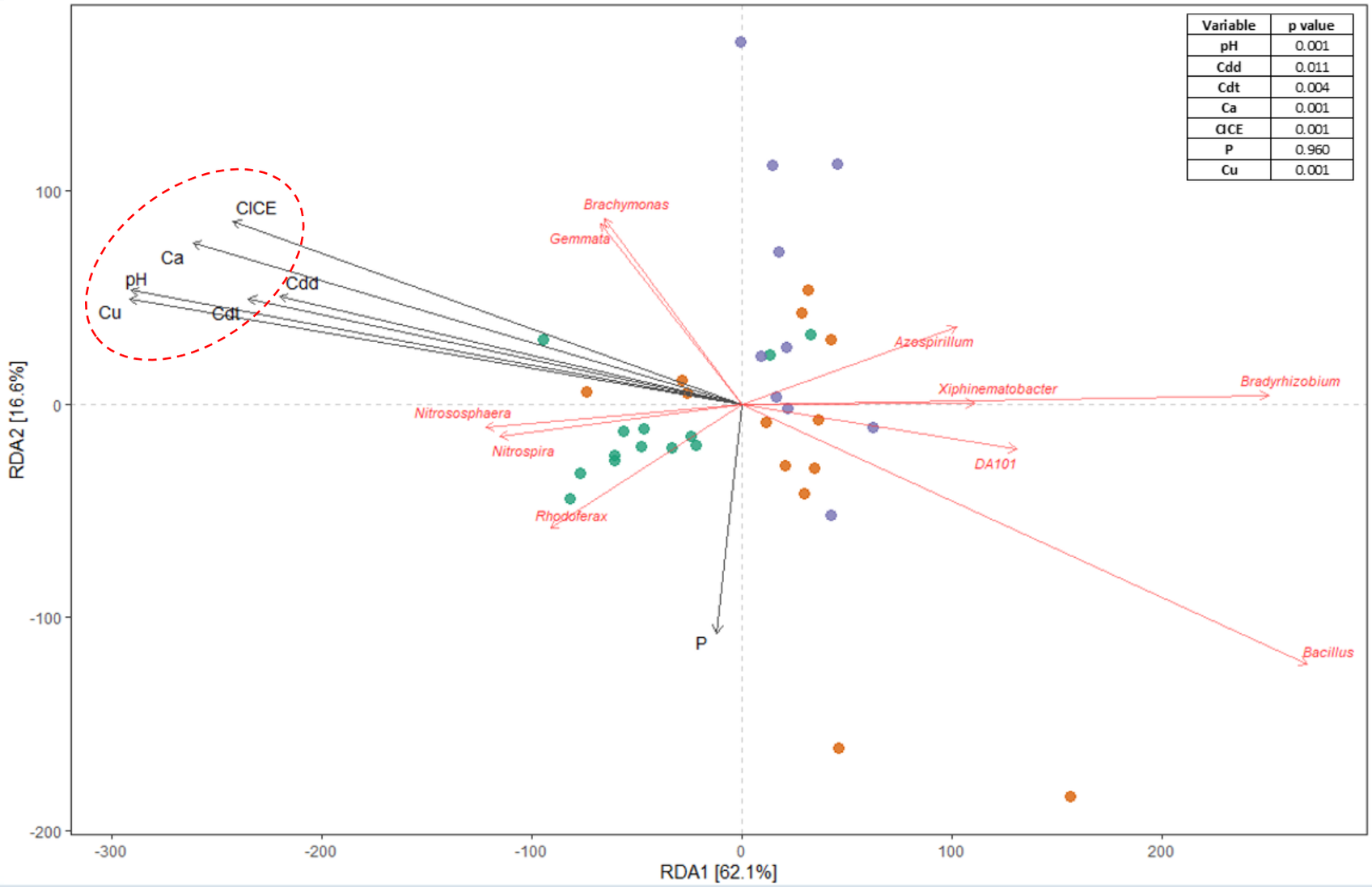


Differential abundance



- 39 phyla and 122 different bacterial genera were identified.
- The phylum Nitrospirae and Actinobacteria were more abundant in **F1.**

Results: Correlation between physicochemical variables and bacterial communities

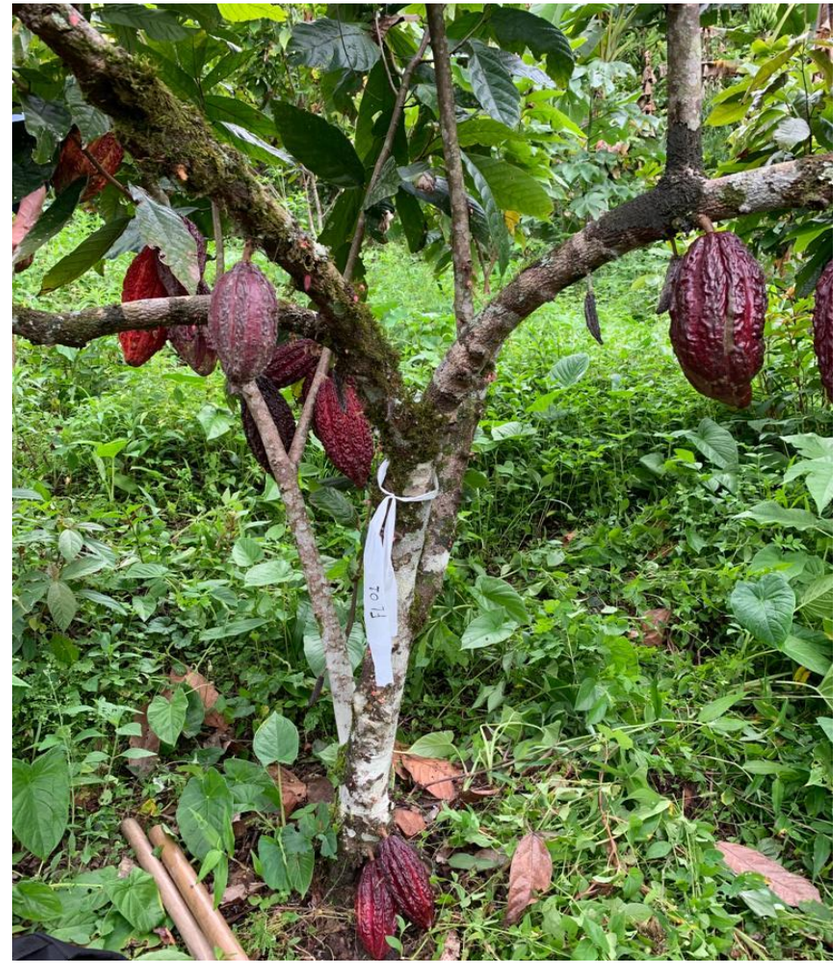


- The pH, Cu, Ca, CICE and Cdt most highly correlated with diversity of the bacterial community.

- *Bradyrhizobium* and *Bacillus* genera were the most abundant.

Conclusions

- The level of Cd present in the soils was variable and higher than the levels permitted in agricultural soils.
- The rhizospheric soil of F1 had the highest concentration of Cd and the greatest diversity.
- The bacterial communities present in cacao soils have high diversity and uniformity, with the capacity to adapt to high concentrations of Cd.
- The abundance of the genera *Bradyrhizobium* and *Bacillus* suggest that these two genera are potential microorganisms for the bioremediation of soils contaminated with Cd.



Acknowlegdements

- To the research division of the National University of Colombia (Hermes Project: 42156).
- To the farmers of the municipality of Yacopí for allowing access to the sampling area.
- To the Agrobiotechnology and Agrobiodiversity group of the National University of Colombia for the support provided during the development of this research.

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