Ciliated protists as indicators of soil health: Three case studies from Italy

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➢*Protists: key multi-channel feeders in the soil food web*

✓One of the most diverse and abundant group of soil eukaryotes an essential component of the ***rhizosphere microbiome.***

The Functional versatility of soil protists!

Phagotrophy

Protozoa:
- ➢**Ciliates**;
- ➢Flagellates;
- ➢Amoebae.

Phototrophy

Algae, e.g. diatoms

Saprotrophy

Organic matter degradation
(e.g., *oomycetes , fungus-like protists)*

Symbiosis

Parasitism, mutualism etc.

All functional groups of soil protists provide critical roles in nutrient cycling.

Aims: to provide an overview of *the outcomes and challenges encountered using ciliated protists as indicators of* ***Soil Health*** in the framework of several projects conducted in Italy since 2009.

1st The BioPrint Pilot Project

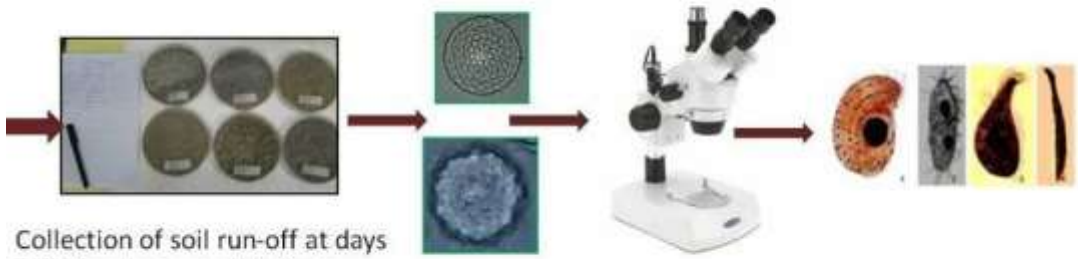
2nd Ciliates in organic vineyards

3rd Ciliates in industrial sites – Soil Mapping Lombardia

A "Classical" Methodological Approach:

Qualitative-quantitative analysis of the ciliate diversity and community structures at the investigated sites.

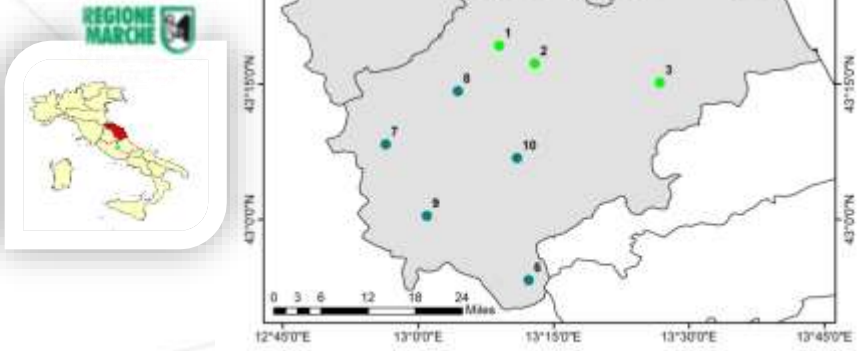
1) Non-Flooded Petridish" methods (Foissner in Protocols in Protozoology, 1992)
2) Live observations;
3) Fixing and Slide preparation;
4)Protargol staining;
6) Identification (genus/species level) & direct counting on slide;
7) Data analysis (diversity indices & multivariate statistics)



Collection of soil run-off at days 2,4,7 (up to 1 month), fixing, slide preparation and protargol stain.

Case studies across Italy. 1st The BioPrint Pilot Project

Main aims: *to evaluate the capacity of ciliates to discriminate between different land uses (forests and agroecosystems) and farming management practices (organic vs conventional) with different level of soil disturbance.*



Agroecosystems

*Light green dot- **ORG**anic (n:3; minimum tillage)*

*Yellow dot- **CON**ventional (n:2; Sod seeding – No-tillage and chemical weed control)*

Forests

*Dark green dot- **FOR** (n:5; undisturbed soil)*

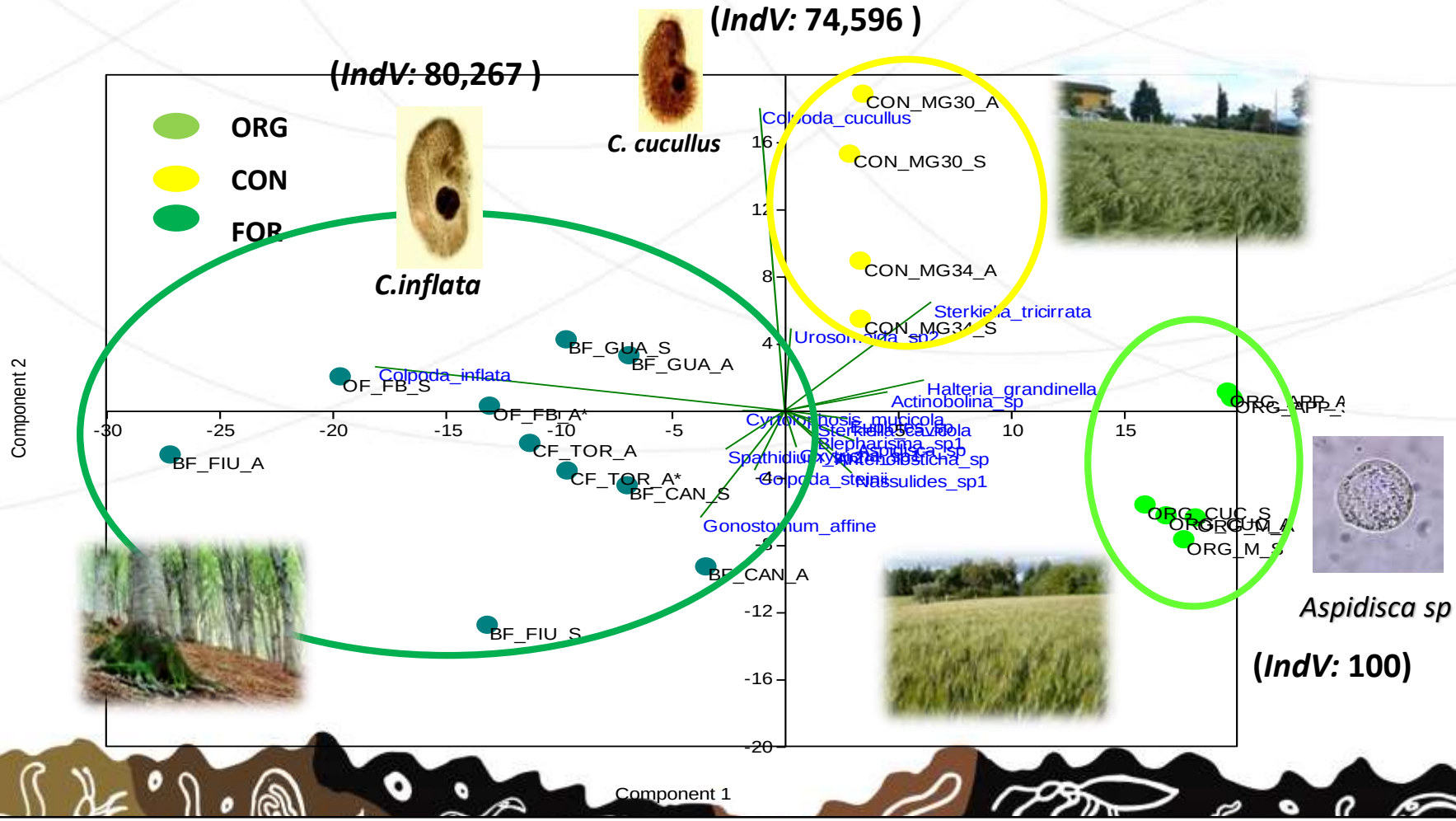
(BF:beech forest; OF: oak forest; OF: cheastnut forest)

Time Schedule and Sampling

- Soil samples were collected in spring (S) and autumn (A) (2011)
- 10 soil samples (0–10 cm depth in an area of 100 m^2) were randomly collected with a Edelman auger, mixed together to obtain a composite sample.

Different land use types host different ciliated protist communities and are characterized by different sets of Indicator Species (ISA, Dufrene & Legendre, 1997)

PCA for spatial taxonomic patterns of soil ciliates for square-root transformed species-abundance data for the 3 site types

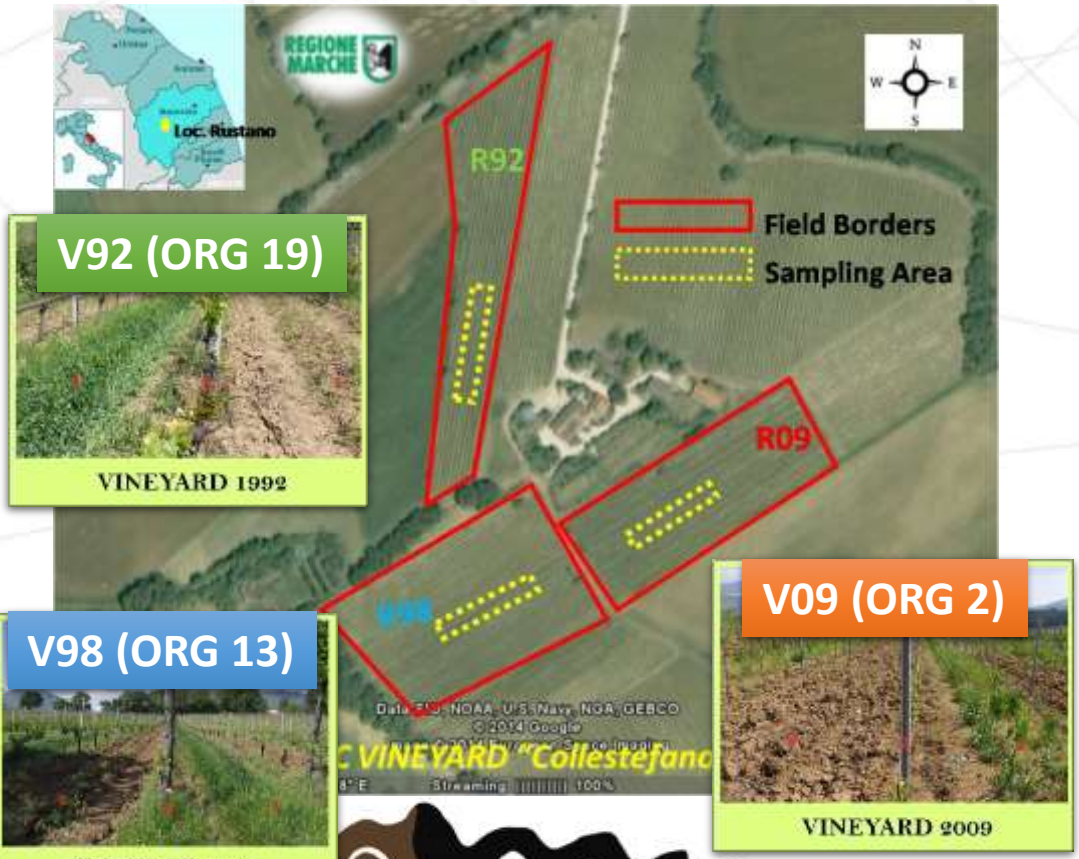


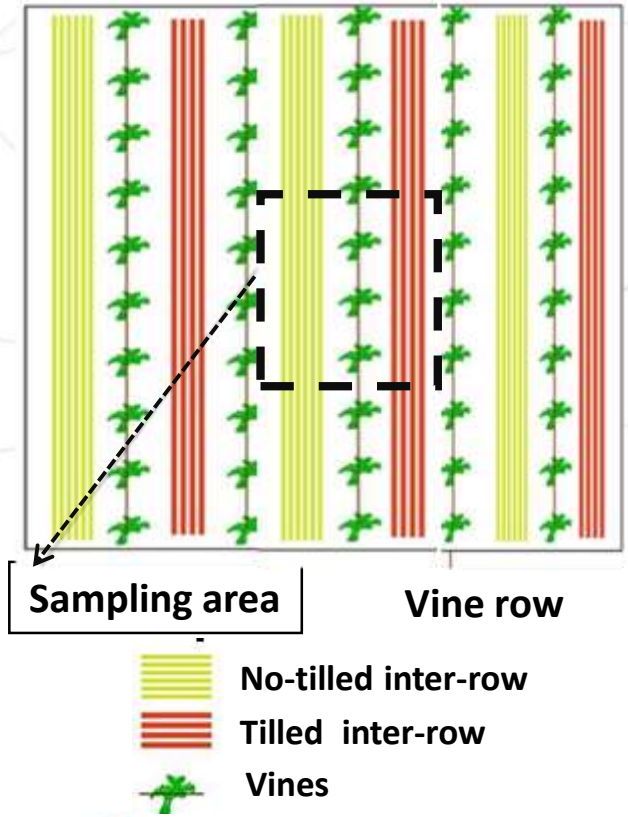
*Axes 1 and 2 respectively accounted for 51.5 % and 15.9 % of the total variation present. One-way ANOSIM revealed significant global differences among the 3 sites (Global R= 0.85; p=0.0001) and between each pair of groups (**p<0.01).*

Case studies across Italy. 2nd Ciliates in organic vineyards

Aim: *to assess the long term effect of organic floor management on Soil Health by mean of ciliates communities analysis in 3 vineyards which were organically managed for 19 years (V92), 13 years (V98) and 2 years (V09) respectively*

3 sampling in May, June and July 2011



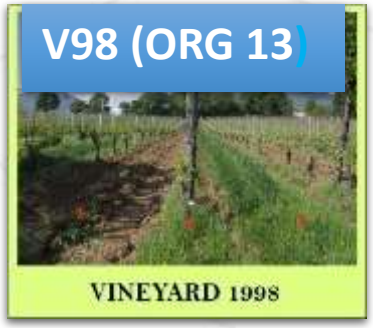


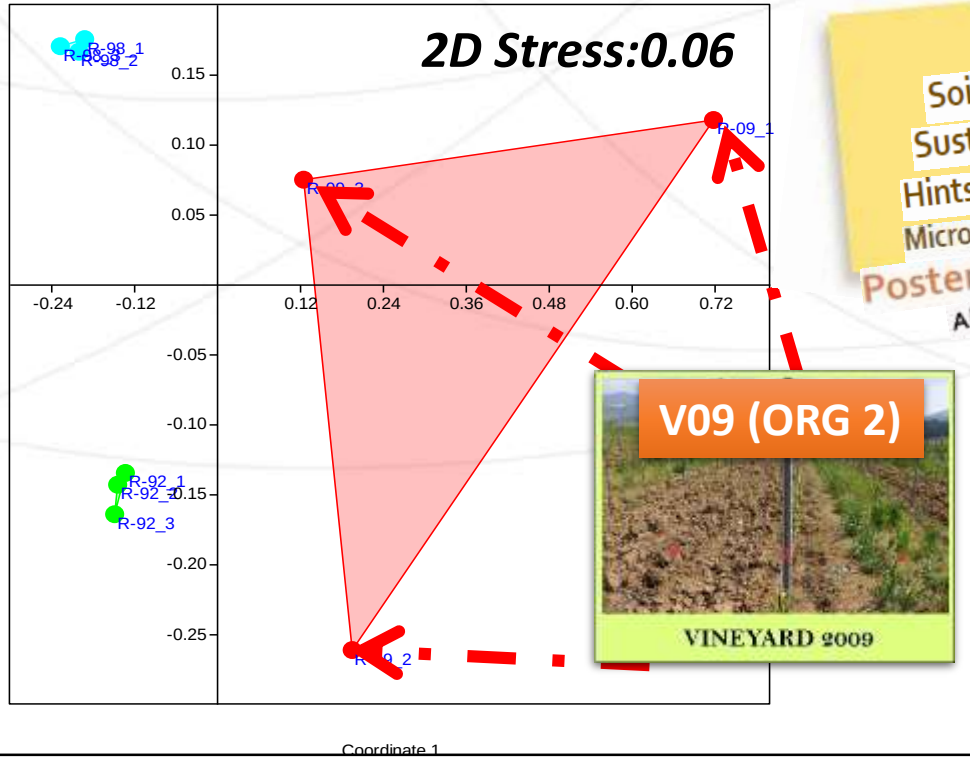
Vineyard floor management: alternate management of the tractor-rows on either side of the vine row with tillage and no-tillage annual cover crop species.

The "oldest" vineyards host more stable ciliate communities than the "youngest" vineyard

Non-metric Multidimensional scaling (nMDS)

for spatial taxonomic patterns of soil ciliates from log transformed species-abundance data on Euclidean Distances, for the 3 vineyard, V92, V98 & V09 - Convex Hull





Soil Biodiversity and Sustainable Vineyards: Hints From the Analysis of Microarthropod Communities

Poster session - Theme 3

Aldo D'Alessandro

QBS-ar siss

- *Overall, the ciliate communities show less fluctuations (> stable) in the "older" vineyards compared with the "younger" **V09** vineyard (**V92**>**V98**>**V09**).*
- *This effect may be due to the greater soil resilience, possible achieved during the long term organic management of the vineyards **V92** and **V98***

Case studies across Italy. 3rd Ciliates in industrial sites

Aims: i) *to evaluate the potential of soil ciliate communities to discriminate between different levels of soil contamination/disturbances in four industrial areas (Incinerator; SIN, Site of National Interest; Viscolube, Plant of regeneration of exhausted oils; Cement factory) of Lombardia Region; ii)* to assess relationships among ciliate communities and abiotic (environmental & contaminant parameters).

Four areas for a total of 30 sites were sampled.

Contaminated Site of National Interest

- As; Tl;Cu; Hg; Zn; Pb…..
- POP (PCB, PCDD, PCDF…)

Italcementi, Cement Factory

- Cu
- POP

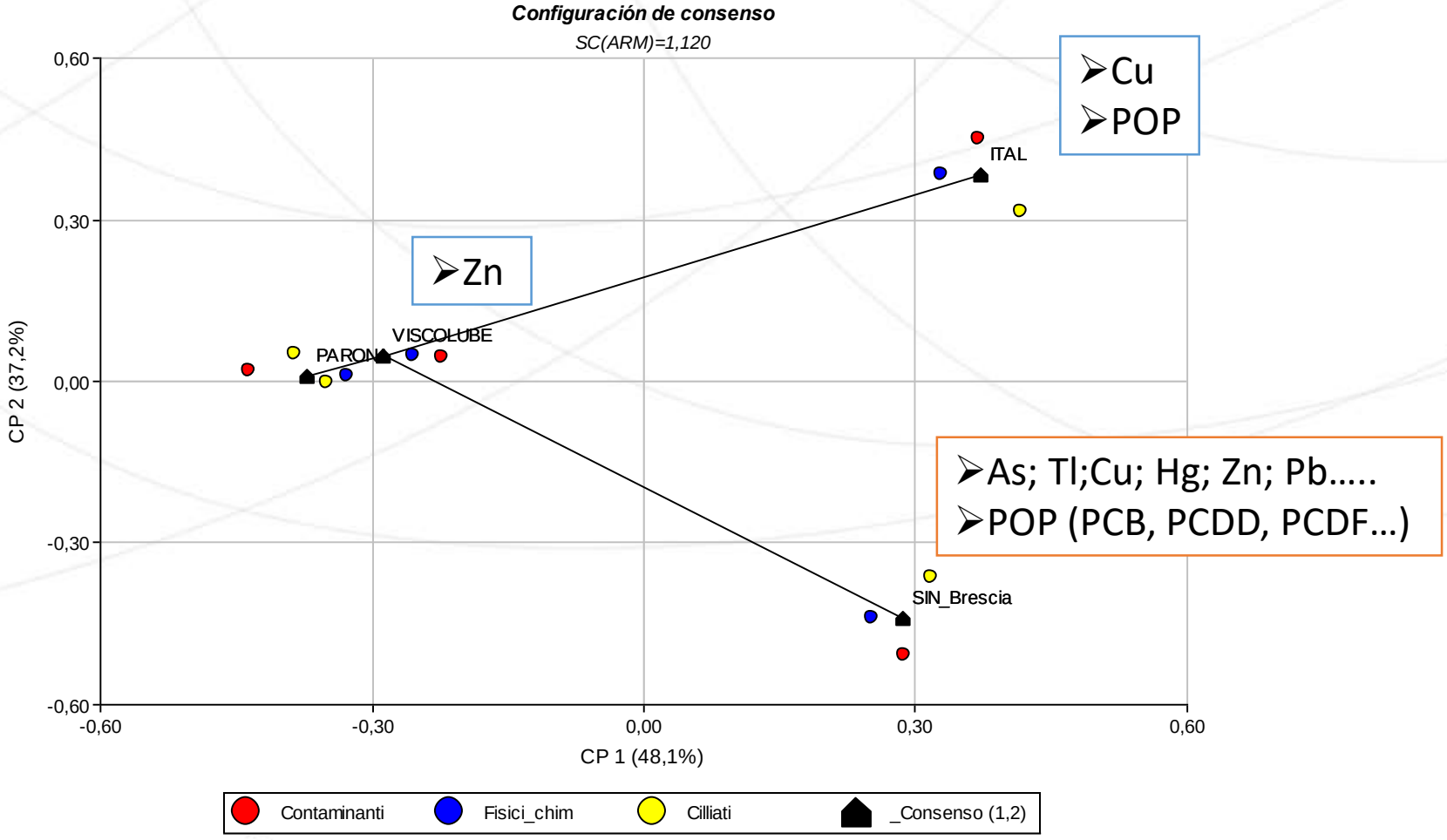
Viscolube

- Zn

Incinerator, Parona

What is the contribution of Chem-Physical and contaminant variables in shaping the community structures of ciliates at the 4 sites?

A Statistical Shape Analysis: Generalized Procrustes Analysis (GPA)



***Total Consensus Matrix (groups)*: 0.917;**
Group contribution values*: *Ciliates: 0.956; Chemical-Physical factors: 0.948; Contaminants: 0.838.

To what extent and how do ciliate communities contribute to soil bioindication?

The 1st C. Study ORG vs CON vs FOR

- *discriminating between natural (FORest) and agroecosystems, and different management systems (ORGanic vs CONventional).*
- *providing "land-use" sets of Indicator Species*

The 2nd C. Study Ciliates in the vineyards

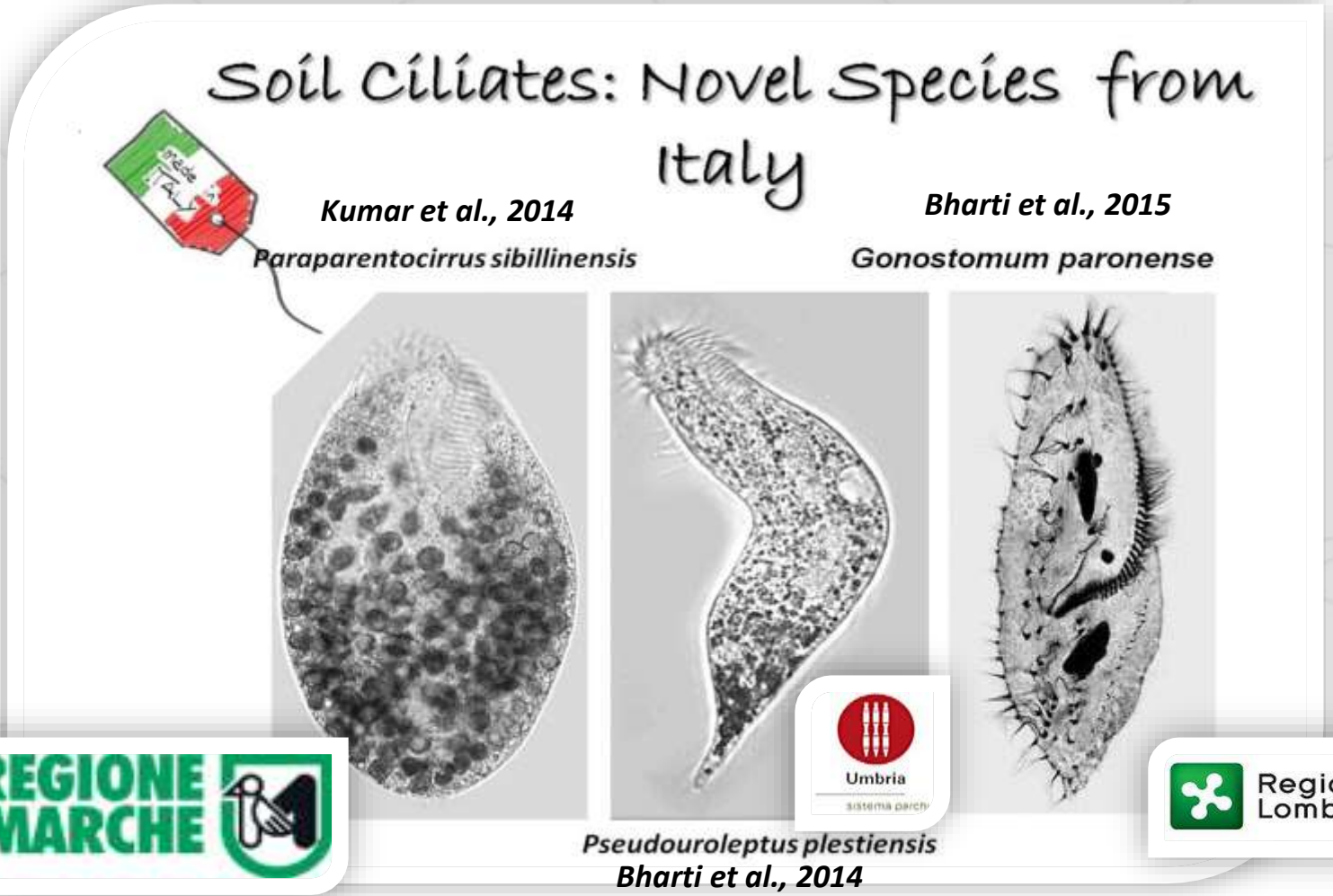
- *acting as proxy of soil resilience in agroecosystems (and thus, as indicators of sustainable land management).*

The 3rd C. Study Ciliates in industrial sites

- *discriminating between different levels of soil contamination in polluted sites.*
- *Showing significant relationships with abiotic (environmental and contaminant) factors.*

Altogether, these outcomes add new knowledge toward a more informed use of ciliates as bioindicators of soil health and broaden our understanding of how land use intensity, agricultural management and contamination levels can shape ciliate communities.

…. a contribution to alpha-taxonomy!



…….and many others!

…..biodiversity inventories are essential to obtain the **baseline knowledge_ which is the prerequisite to monitor ecosystem integrity** _and thus to detect and evaluate impacts of natural and/or anthropogenic disturbances…….(Cotterill et al., 2013)

Acknowledgments

REGIONE MARCHE

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Regione Lombardia

Thank you!

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