



Assessing the impact of agricultural strategies on soil Arthropods: a case study using environmental DNA

Sumer Alali¹, Bessem Chouaia¹, Paola Cremonesi², Giulia Magoga¹, Flavia Pizzi², Stefano Bocchi³, Matteo Montagna^{1*}

¹ Università degli Studi di Milano, Dipartimento di Scienze Agraria e Ambiente-Produzione, Territorio, Agroenergia, via Celoria 2, 20133 Milano, Italy .

² Istituto di Biologia e Biotecnologia Agraria, Consiglio Nazionale delle Ricerche, via Einstein, 26900 Lodi, Italy..

³ Università degli Studi di Milano, Dipartimento di Scienze e Politiche Ambientali, Via Celoria 2, 20133 Milano, Italy.

* Corresponding Author: matteo.montagna@unimi.it

Introduction: Elucidating how agricultural practices affect soil arthropod's communities is of relevant for both scientific and economic interests. The assumption that organic farming enhances the biodiversity in agroecosystems has been proved for birds. However, the impact of these agricultural strategies on soil fauna is still debated. In the present study, using state-of-the-art massive data generation technologies targeting the mitochondrial cytochrome oxidase subunit I (COI), the soil' arthropods communities of selected farms in the Po Plain (Italy) were characterized. The following main questions were addressed: i) is the biodiversity of soil Arthropods higher in organic vs conventional farms? ii) are the field use (crop vs stable meadow) and the field margins affecting the arthropods communities distribution?.

Materials and Methods

Soil samples were collected from organic and conventional farms, covering the margin and three levels towards the center of a stable meadow and a barley field in both farms; each sample consisted of 10 homogenized cores of soil (~560 cm³), sampling was performed in spring, summer and autumn Soil texture, pH, N and C parameters were measured. Farms are located in the municipalities of Albairate (MI) and Cislano (MI).



Fig 1. the sampling scheme and sampling tools

DNA was extracted from three replicates of each soil sample. Fragments of the *cox1* gene (~300 to 650 bp) were amplified using the three pairs of primers (1= COIF2 - COIR2; 2= mICOLintf - JgHCO2198; 3= Foldf-Foldr.), and sequenced on a paired 2X250 bp run on Miseq platform (Illumina, San Diego, CA, USA). Raw sequences were analyzed using Qiime platform. A descriptive statistic was performed to determine the frequencies and percentages of OTUs in samples and sites, the alpha diversity indices of Shannon (H') and Pielou's evenness were calculated. Finally NMDS (nonparametric multidimensional scaling) analysis were performed and the farming system, the field, the position and the soil properties were fitted as factors.

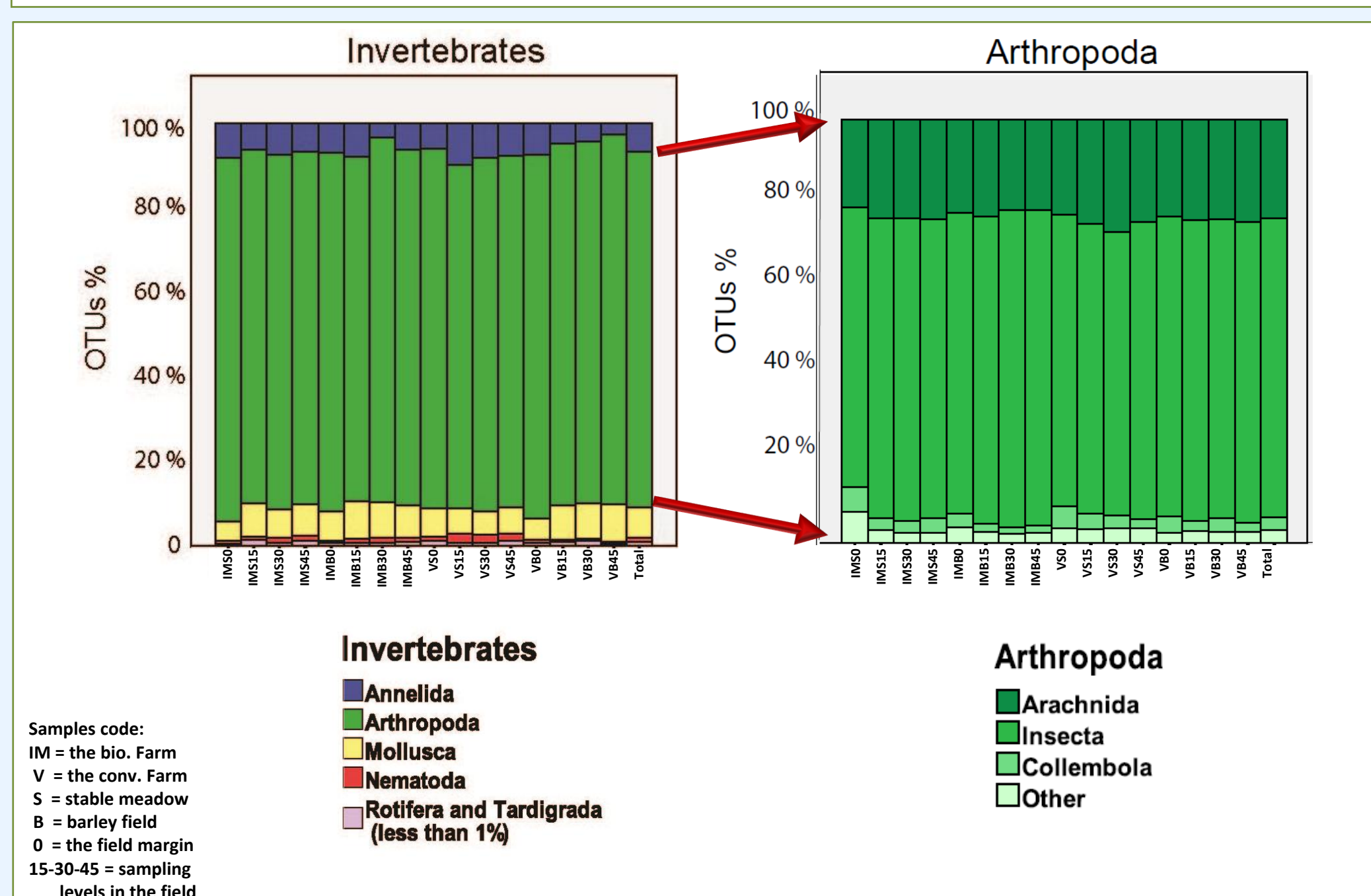


Fig 2. percentages of OTUs assigned in Invertebrates and Arthropoda

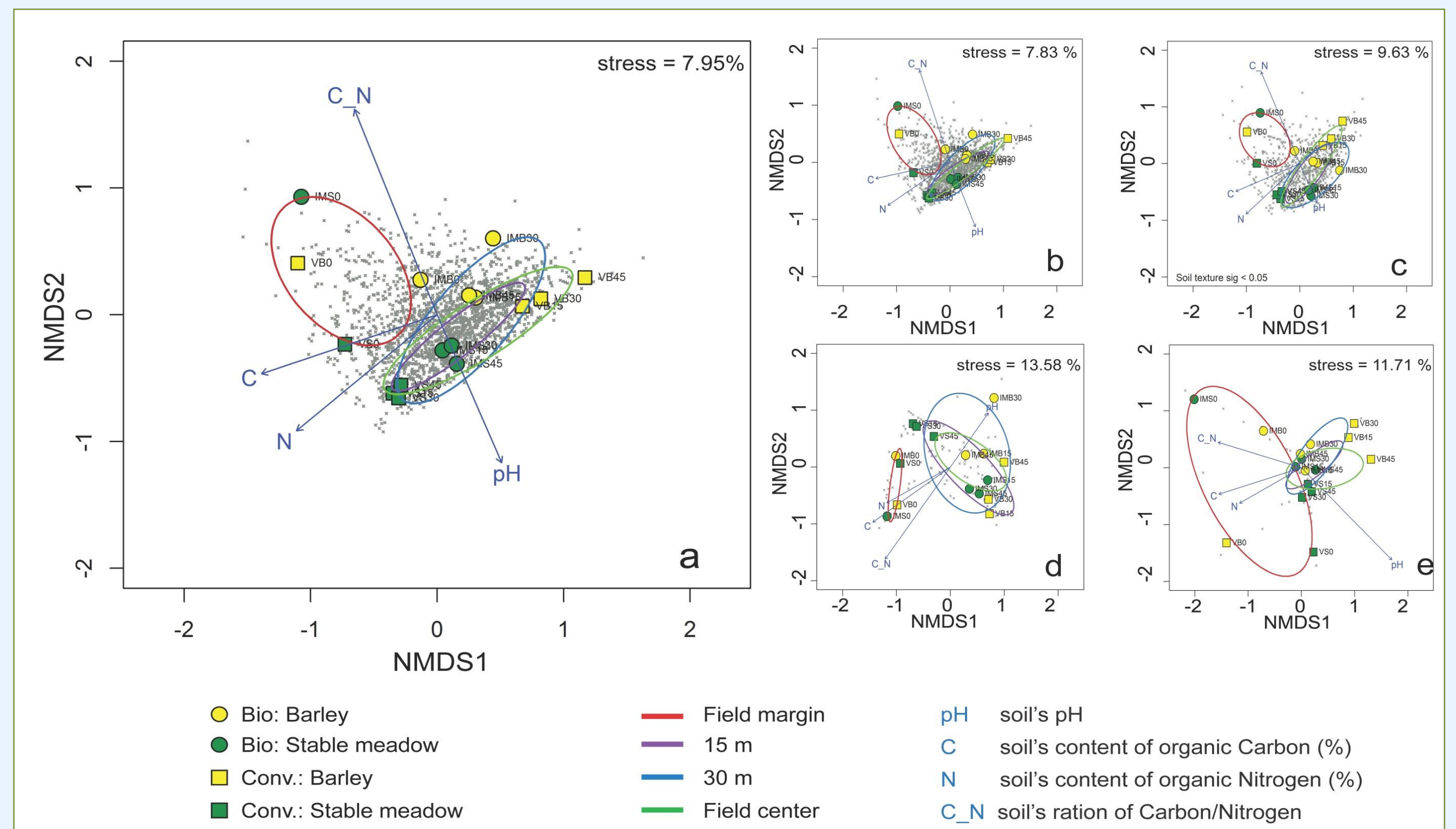


Fig 3. Biplot of the 2-dimensions NMDS representing correlations between the Arthropods' communities and both farming and soil features. (a) Arthropoda; (b) Insecta; (c) Arachnida; (d) Collembola; (e) Chilopoda & Diplopoda.

Results

The metabarcoding libraries yielded about 13,000,000 paired reads. After the removal of the low quality bases, chimeras, contaminants, and rare sequence types, and following the normalization steps described in the materials and methods, a total of 2,313,488 reads were assigned to 18,035 OTUs (13,551 of Animalia (~ 75%), 3,602 of Fungi, 466 of Bacteria, 3 of Archea, 28 of Plantae and 384 Unknown sequences from Blast.

Among the Invertebrates in Animalia kingdom, ~80% were assigned as Arthropods (Fig1). α -diversity indices barley field in conventional farming were significantly lower (OTUs= 854, H' = 5.34±0.53, Pielou's evenness= 0,77±0,06) comparing with the other samples (OTUs> 1100, H' > 6 and Pielou's evenness> 0,8). Fitting the farming system, the field, position as factors in NMDS showed that Arthropods communities were not affected by the collecting season and the farming system (organic vs conventional), instead crop vs stable meadows and the position in the field (margin vs middle) have a strong effect. Soil properties affected the Arthropods communities, especially the pH on Chilopoda and Diplopoda and the C/N ratio on Arachnida and Insecta.

Conclusions

Our results pointing out that the strategy of farm management does not affect the arthropod communities of the soil as much as the soil properties itself, while the position in the field had a major effect, highlighting the importance of green corridors for maintaining the soil biodiversity and the agroecosystem functioning.