easynem: an R package for computing and visualizing soil nematode ecological indices

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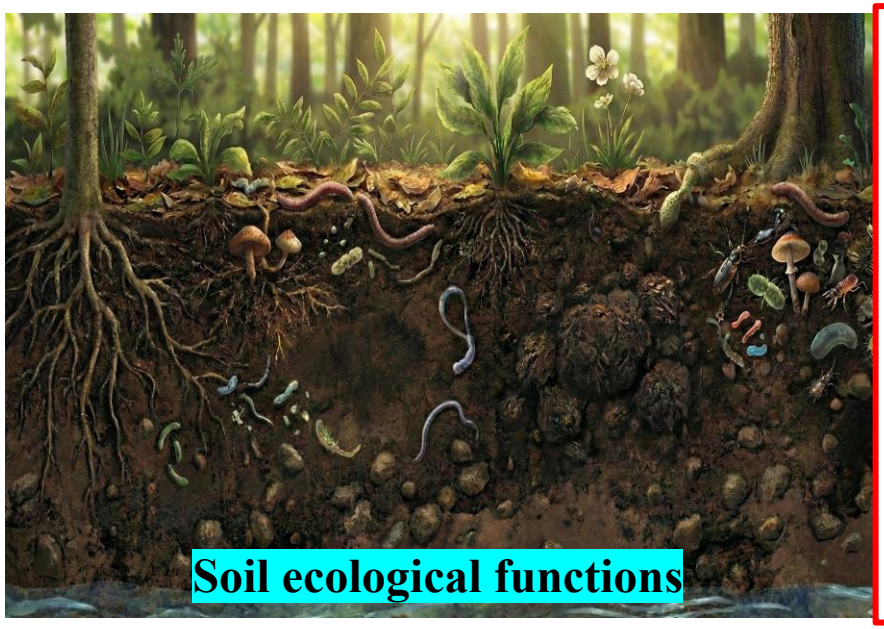
Introduction



Data Preparation

Abundance | Taxonomy | Test design

Genus	Family	Feeding	Cp_value	.....
Aba...	Mer...	Herbivo...	1	.....
Abb...	Phy...	Funivor...	3	.....
Abe...	Enc...	Bacteri...	3	.....

Data reading
- read_nem()
- read_nem2()

Automated linking to soil nematode databases

Database visualization
- nem_database()

Data Pre-processing

Data filtering
- filter_name()
- filter_num()

Data transformation
- trans_name()
- trans_formula()
- trans_norm()
- trans_rare()
- trans_combine()

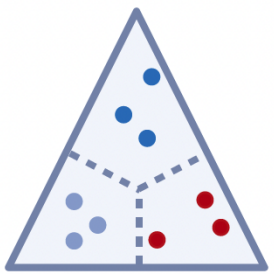
Calculation of Nematode-based Indices

Nematode community
- calc_alpha()
- calc_beta()
- calc_nemindex()
- calc_ter()
- calc_compare()

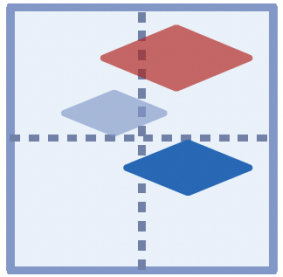
Nematode-based indices
- calc_funguild()
- calc_mf()
- calc_ef()
- calc_lm()

Data Visualization

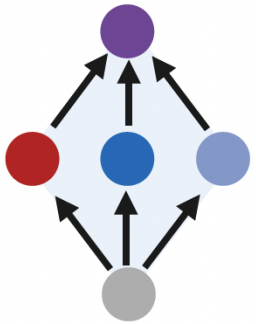
- nem_plot()



Life-history strategy



Metabolic footprint

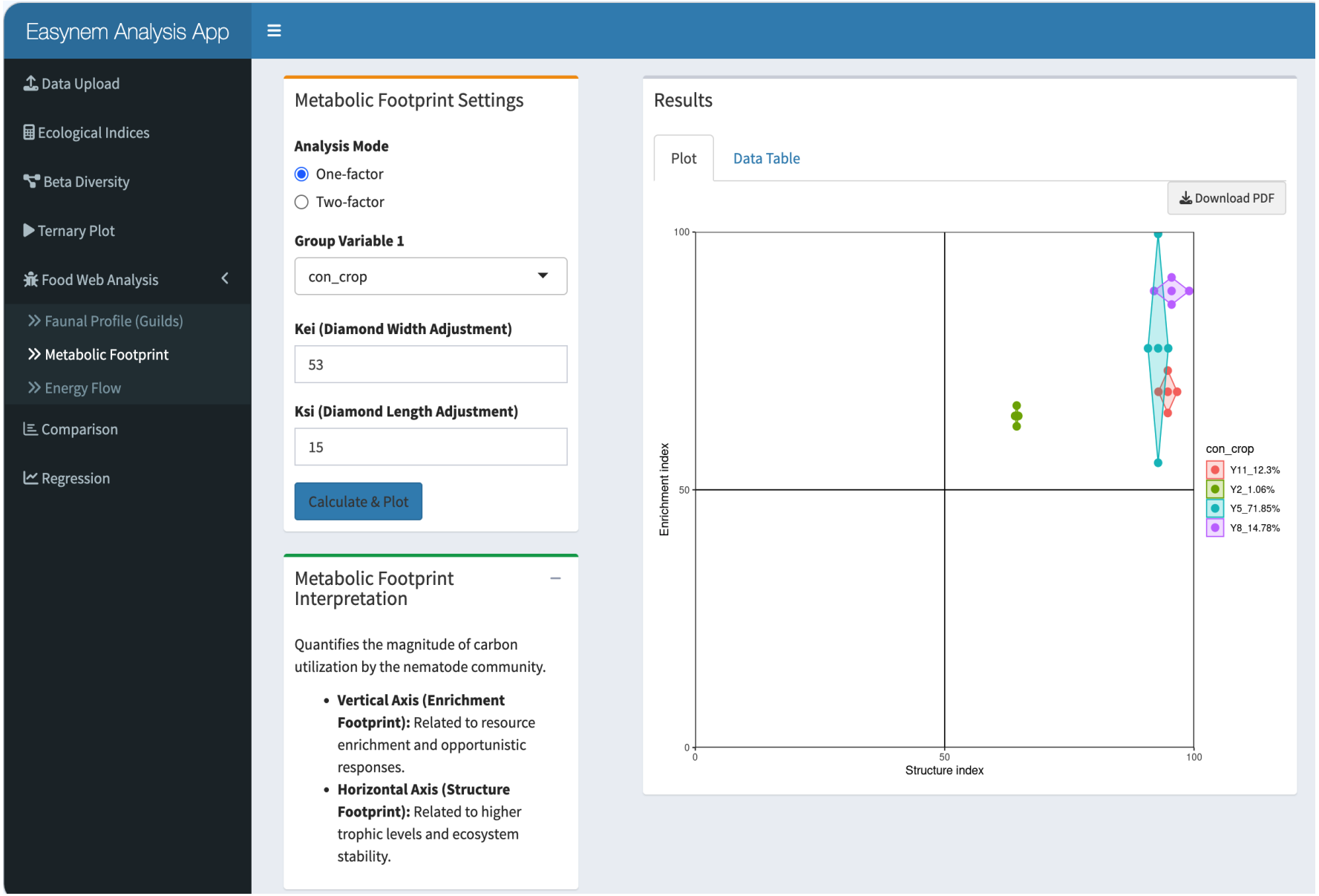


Energy flows

Highlights

```r
# Installing and loading easynem
install.packages("easynem")
library(easynem)
# Import data
nem <- read_nem2(tab = nemtab,
                 tax = nemtax,
                 meta = nemmeta)
# Metabolic footprint analysis
p <- nem |>
  calc_nemindex() |>
  calc_mf(con_crop) |>
  nem_plot(kei = 53, ksi = 15)
```

R Code



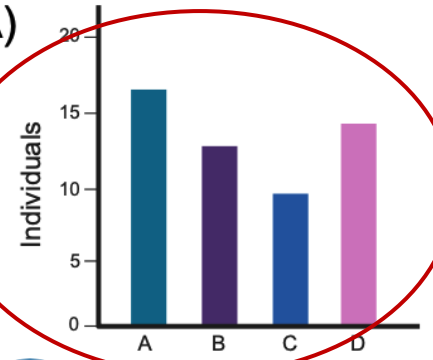
https://whkygl.shinyapps.io/Easynem_Analysis/

Overview of Nematode Ecological Indices

Abundance and diversity

- Species Richness (S)
- Simpson Index (D)
- Shannon Diversity Index (H')
- Pielou Evenness Index (J')

(A)

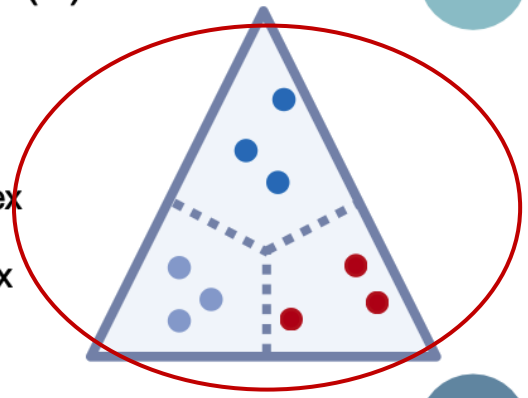


1970

Life history strategies

- Cp-triangle
- Maturity Index 2-5
- Sigma Maturity Index
- Plant-Parasitic Index
- PPI/MI

(B)

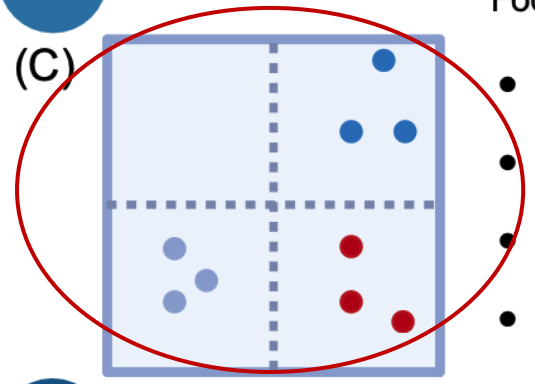


1990

Food web and faunal analysis

- Enrichment Index (EI)
- Structure Index (SI)
- Channel Index (CI)
- Basal Index (BI)

(C)

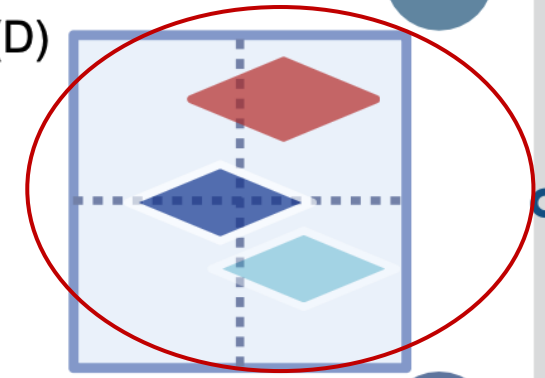


2000

Metabolic footprints

- Enrichment Footprint
- Structure Footprint
- Functional Footprint
- Aggregate Footprint
- Herbivore, Bacterial and Fungal Footprints

(D)

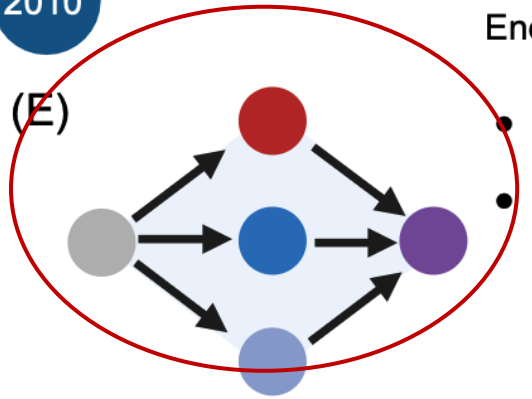


2010

Energetic structure

- Energy Flux
- Uniformity (U) of Soil Nematode Energetic Structure

(E)



NOW

Case 1: Trophic Groups and Life History Strategies

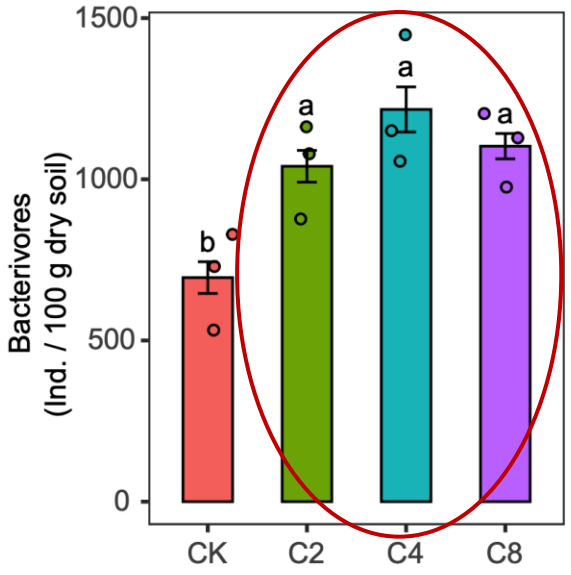
Kiwi orchard mulching experiment

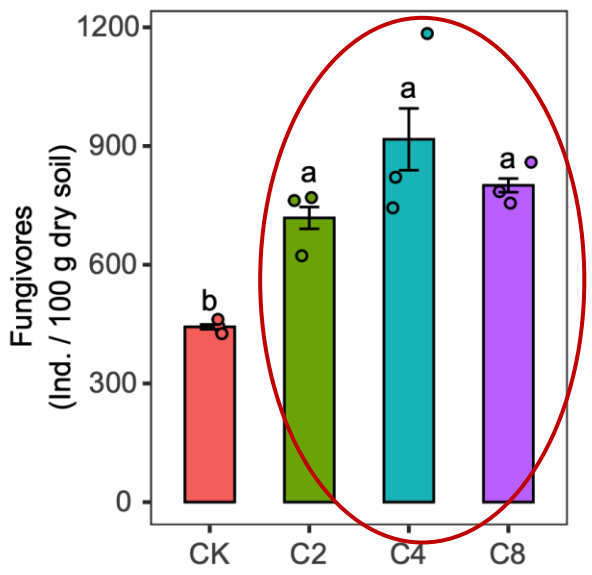
CK: No crop cover

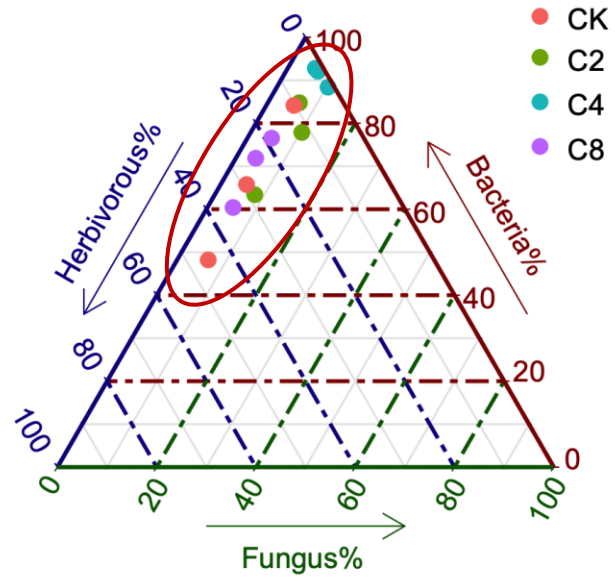
C2: 2 types of crop cover

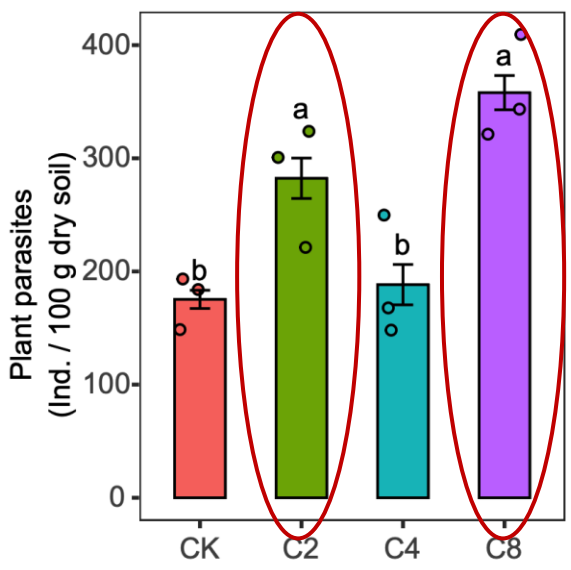
C4: 4 types of crop cover

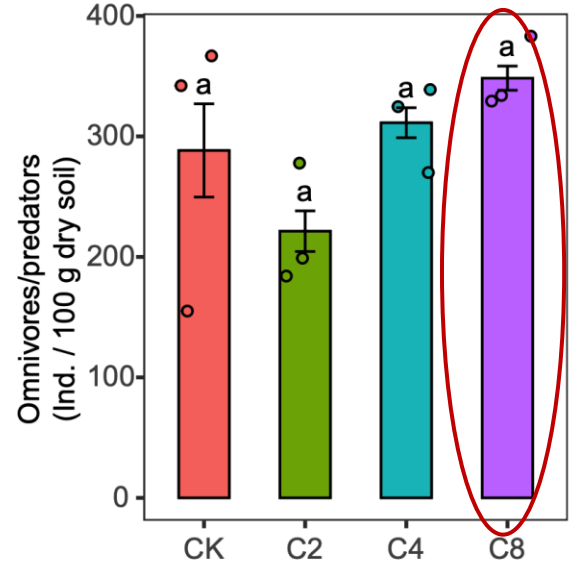
C8: 8 types of crop cover











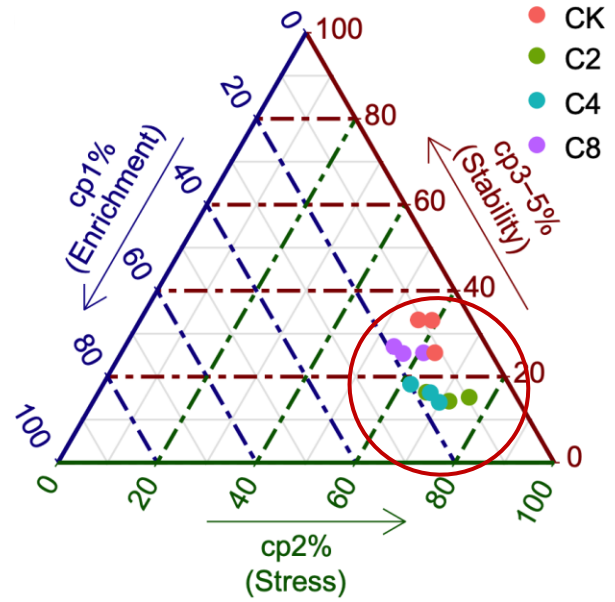
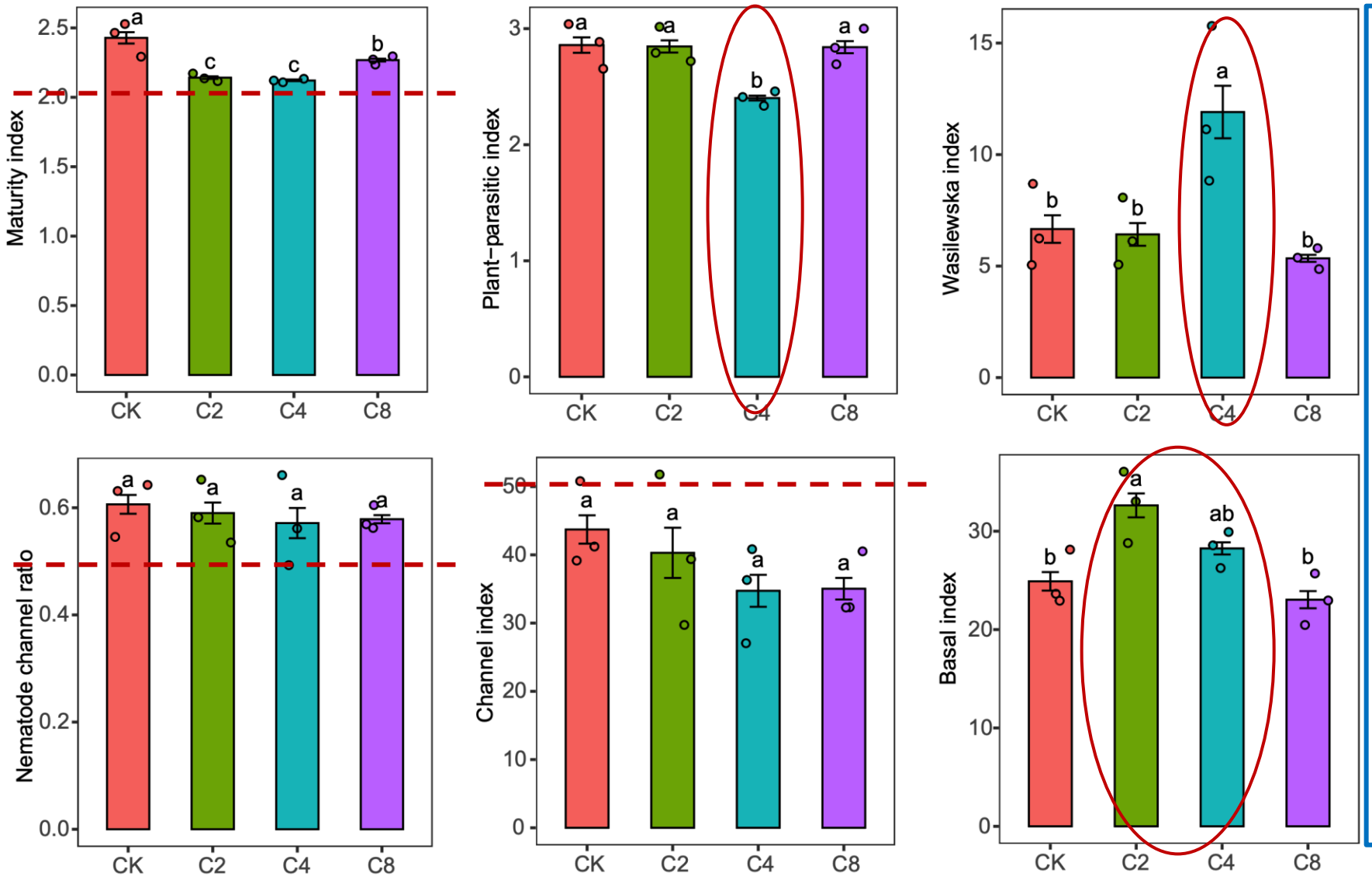


Figure 1. Distribution of trophic groups and life history strategies of soil nematode communities under different cover crop

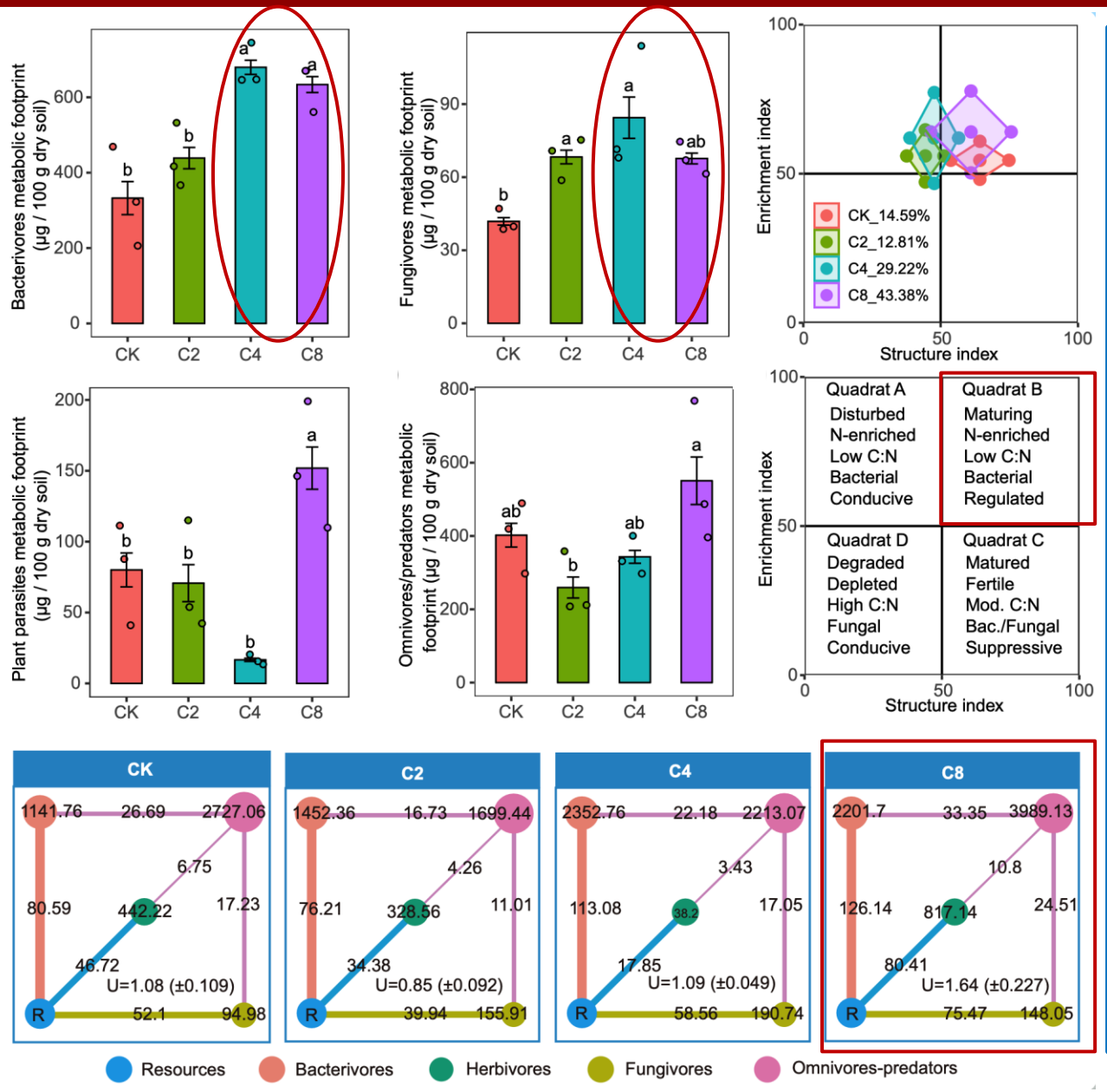
Case 2: Soil Nematode Ecological Indices



- MI > 2, The soil in the kiwifruit orchard is severely disturbed.
- The low PPI value of C4 indicates that the plant-parasitic nematodes are mainly small to medium-sized.
- The high WI value of C4 indicates a high proportion of nematodes that feed on bacteria and fungi.
- NCR > 0.5, CI < 50, The degradation pathway of organic matter is primarily mediated by bacteria.
- The increase in BI for C2 and C4 indicates basal nematode growth.

Figure 2. Variations in soil nematode-based indices under different cover crop treatments

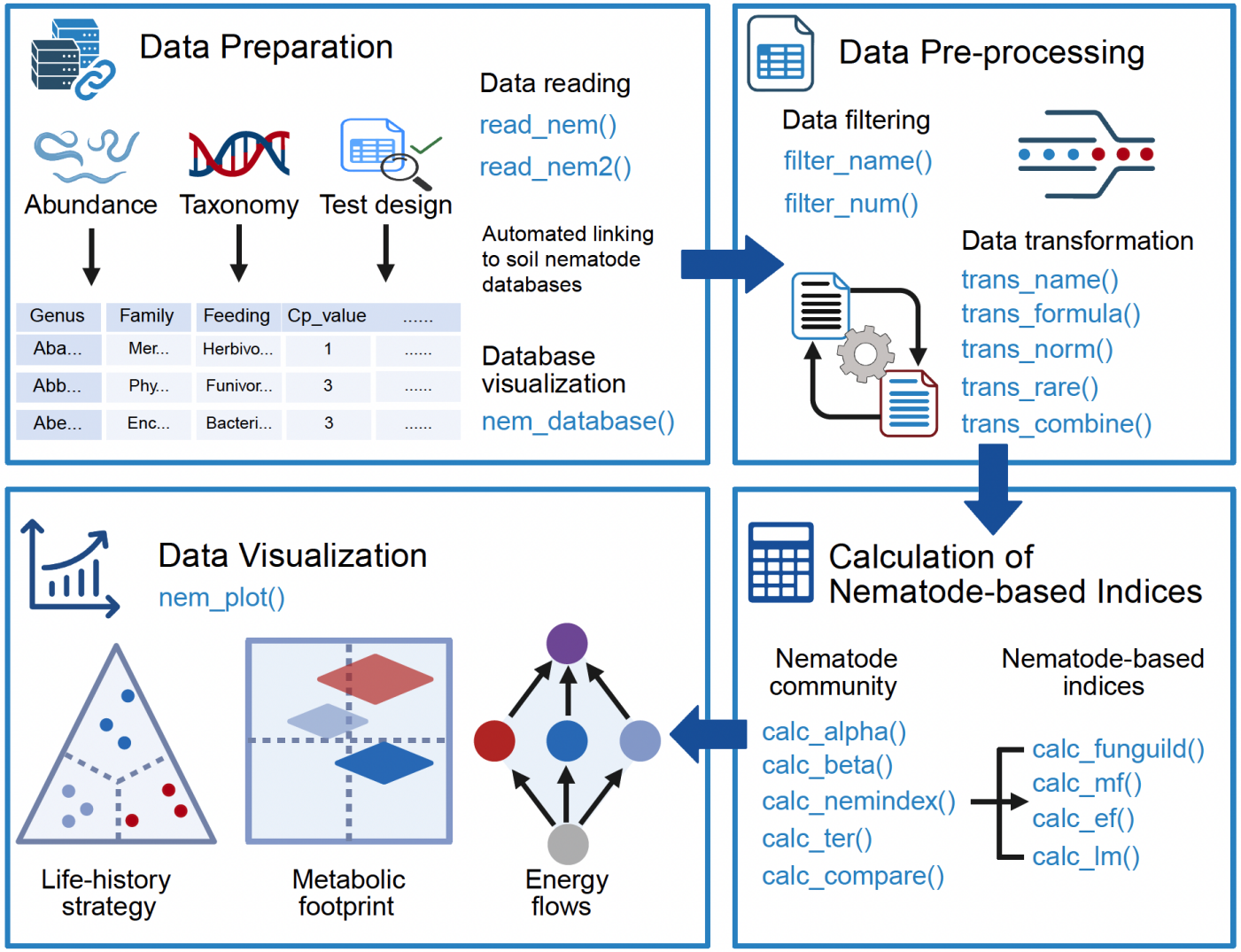
Case 3: Metabolic Footprints and Energy Structure



- C4 and C8 treatments showed significantly higher metabolic footprints for bacterivores and fungivores than CK, indicating enhanced nematode activity and ecological contribution.
- C8 and CK grouped into faunal analysis Quadrat B, reflecting good nutrient status, low disturbance, and a stable, mature food web.
- C8 displayed a higher functional metabolic footprint than C2 or C4, suggesting it most effectively promotes predatory omnivore activity.
- Compared to CK, C8 increased biomass and energy flow across trophic groups, resulting in the most uniform energy structure.

Figure 3. Analysis of metabolic footprint, faunal profiles, and energy structure of soil nematode communities

Summary



- *Easynem* is a user-friendly and flexible R package that streamlines the complex analysis of soil nematode communities for evaluating soil health.
- It offers an integrated workflow for data processing, calculation of dozens of ecological indices, and comprehensive visualization of results to generate meaningful ecological insights.

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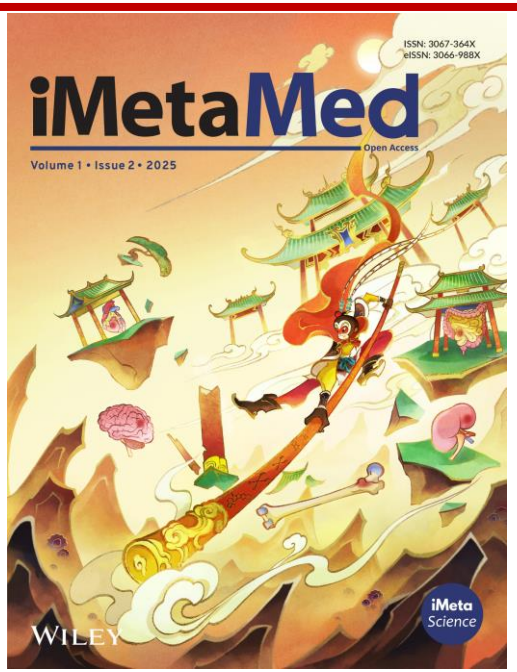

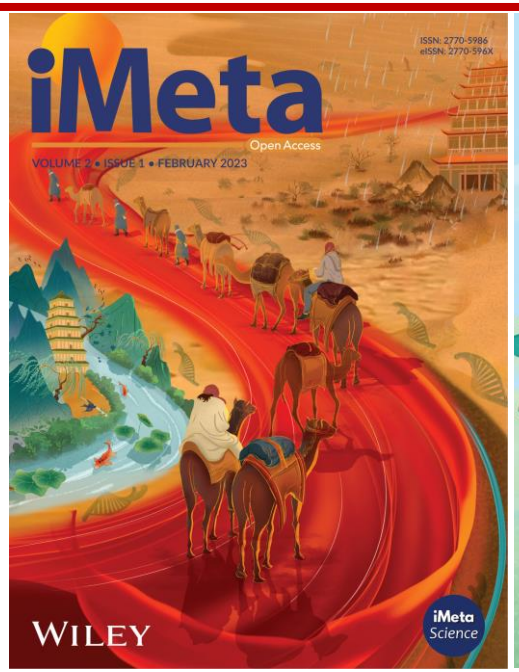

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