TOOL WORKSHEET NO.8

Soil microarthropods

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DESCRIPTION OF THE INDICATOR

Name of the indicator:

Soil microarthropods (acari and springtails), bioindicators of soil quality.

Photo 1: Springtails

© Photo : Philippe Lebeaux

Ecological role of the organism under test

Soil microarthropods do not constitute a taxon in the strictest sense of the word. They are members of the arthropod branch. They share a minute size at adult stage (in general less than a cm of total length). They are mostly represented by **acari and springtails (Photograph 1)**, the microarthropod groups generally most found in soil, with overwhelming specific abundances and richnesses (Lavelle and Spain 2001). Microarthropods also include larvae and imagos of Pterygotan insects, Protura, Diplura, Thysanura and Pauropoda. They perform their whole development cycle in litter and the first centimetres of soil. They are the most abundant non aquatic animals in most ecosystems (Bardgett and Cook 1998; Joosse 1981). Soil microarthropods are primarily **decomposers**, impacting bio-geo-chemical cycles.

They also are considered as regulators (Lavelle and Spain 2001). Microarthropods are said to be particularly active at the level of litters because they facilitate dispersion of microorganisms; they also allegedly help fasten decomposition by transforming initial resource into fecal pellets. That is the reason why they are so often called **"litter transformers"**. However, it is clear that microarthropods can also intervene in other soil components, such as rhizosphere, and are not compelled to litters. Their presence is simply linked to their main resource: organic matter. This organic matter is at the basis of soil trophic networks.

Type of indicator: Bioindicators of effect: the analysis is conducted on the abundance of taxons (acari and springtails) and functional groups (springtails), as well as on richness and diversity (springtails).

DESCRIPTION OF THE SAMPLING METHOD

Reference standards and/or protocols

Sampling protocols are nowadays well defined and standardised (ISO 23611-2:2004). Sampling protocols for soil microarthropods are equivalent to those used in the "RMQS biodiversity" program in Brittany (Cluzeau et al., 2012).

Sampling plan and method

Samples are usually collected in the spring using a standard 5-cm-diameter and 5-cm-deep core drilling (figure 1, left). Several samples (a minimum 3) are necessary for each sampling area.

Storage and pre-treatment of samples

At the laboratory, microarthropods are dry-extracted using a McFadyen-type extractor (figure 1, right). The animals, initially collected in benzoic acid, are subsequently transferred in 70% alcohol. They are counted under binocular magnifier. Identification of springtail species is conducted using a phase-contrast microscope (x360), after animals are soaked in Marc André I and mounted on a slide with Marc André II.

Figure 1: Soil sampling of microarthropods and McFadyen-based extraction

Measured parameters

3 groups of acari are identified: Oribatida, Gamasida and Actinedida. Furthermore, all springtails are identified at the specific level after discolouration, mounting individuals on slides, and microscopic observation. Springtails are classified within three functional groups, epi-, hemi- and euedaphic on the basis of morphological criteria (Gisin, 1943, Renaud 2003, Cébron et al. 2011). Finally, other arthropods (Myriapoda, small insects, Protura and Diplura…) are classified within one single group named "other arthropods". In total, 13 biological parameters are used: abundance of each of the 3 groups of acari (Actinedida, Oribatida, Gamasida), total abundance of springtails, abundance of each of the 3 functional groups of springtails (epi-, hemi- and euedaphic), total abundance of acari, abundance of "other arthropods", total abundance of microarthropods, richness of springtail species, specific diversity and equitability of springtails (Shannon index).

Simplified description of the measurement method

General equipment: hand scoop, box for sample transportation, 70% alcohol, labels, benzoic acid, vials, steriliser required for the transfer of samples from benzoic acid to alcohol, scales, binocular magnifier. Specific material: small cores (5-cm-diameter and 5-cm-high cylinders, with detachable closures in both ends), phase-contrast microscope, McFadyen extractor.

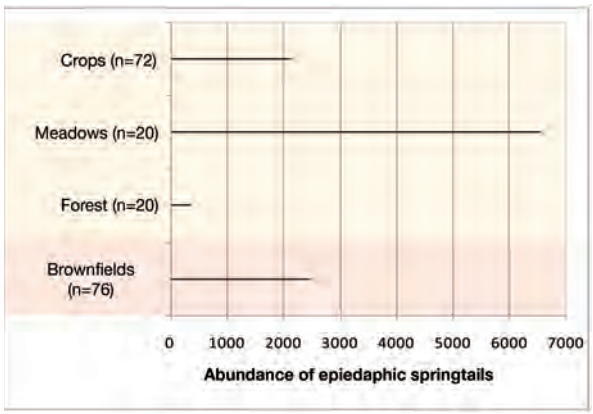
Estimated time

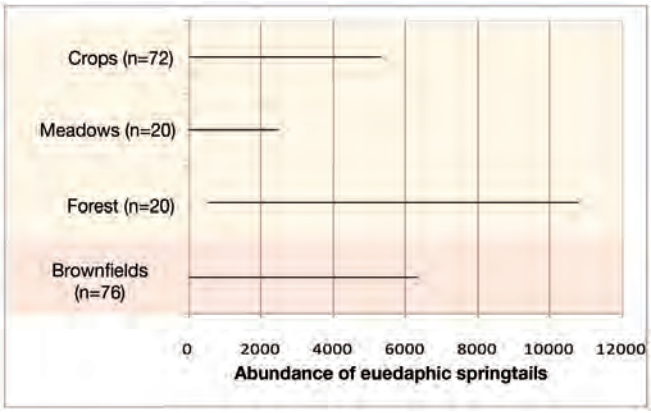
Field sampling: 5 min per sample; simultaneous extraction by groups of 48 samples: 8 days; counting and identification of individuals: between 1 and 2 hours per sample.

INTERPRETATION OF RESULTS

Variation range of microarthropods on the Bioindicateurs sites

Variation ranges of abundances (nb indi/m^2) of epi- and euedaphic springtails on all sites of the Bioindicateur 2 program (excluding extreme values, first and last deciles).





Collected data shows that variation ranges of abundances of springtails vary according to the functional group: variation ranges of epiedaphic springtails are very variable in meadows (between 0 and more than 6000 individuals/m^2) while they are more limited in crops or contaminated soils (between 0 and 2000-2500 individuals/m^2), and very limited in forests (between 0 and a few hundred). Conversely, variation ranges of euedaphic springtails are very large in forests (this functional group has always been sampled in forests, its abundance can exceed 10.000 individuals/m^2), while they are more limited in meadows (between 0 and 2000 individuals/m^2). These values complete those collected at the regional scale on 109 sites in Brittany in the RMQS Biodiv program (Cluzeau et al., 2012).

Database availability/access: Data is searchable and usable, under specific conditions, in a database built during the "Bioindicateurs" program.

Necessary supplementary information (ex: climate, use, type of soil...): The maximum amount of mesological data is required, in particular pedo-climatic conditions (pH, structure, texture), soil use, practices linked to these uses, surrounding vegetation.

EXAMPLE OF APPLICATION

BioREco-Gotheron site (manager: INRA Avignon-Gotheron site): 3 sets of practices for orchard cultivation (Sustainable, Organic, Input-economical)

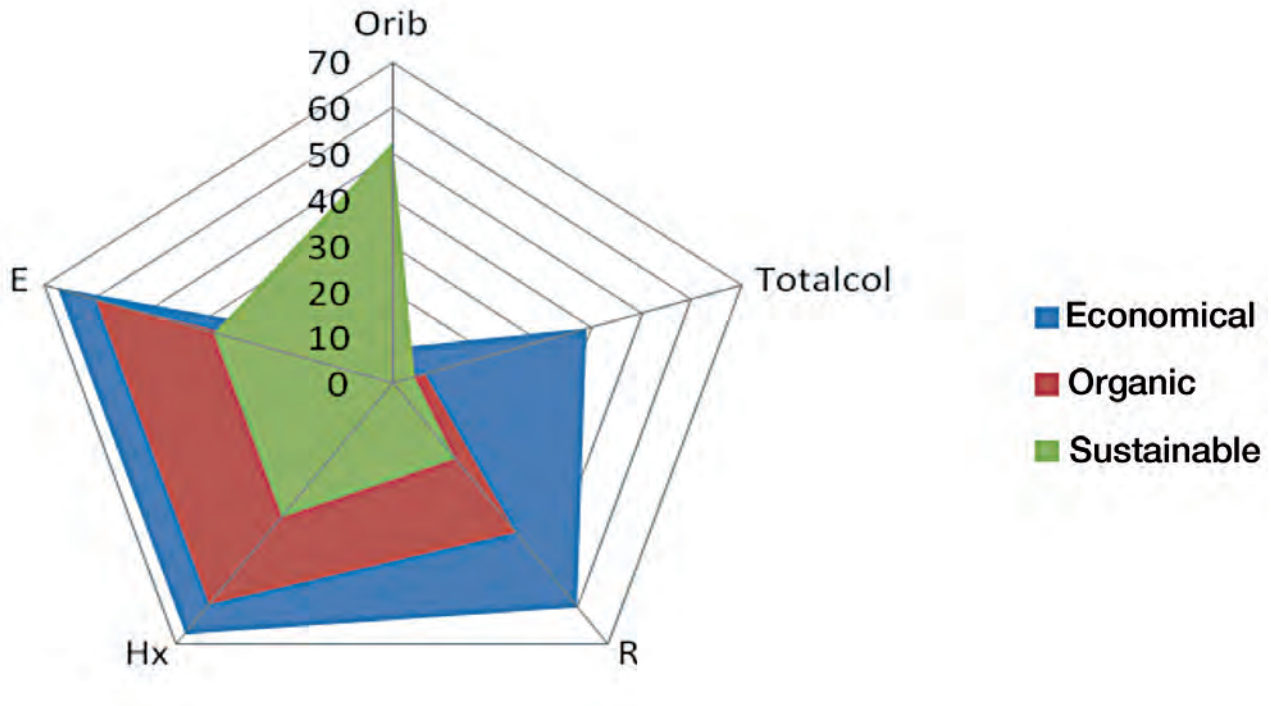


Figure 2: Summarised presentation of the averages of 5 biological parameters on the Gotheron site for each modality. 0 refers to the minimal value and 100 the maximal value observed on the site. Orib: Oribatida, Totalcol: Total springtails, R: Richness springtails, Hx: diversity springtails, E: Equitability springtails.

Results clearly highlight the differences in sets of practices:

- The sustainable system (without risk taking, using traditional chemical protection) shows low abundance of springtails, with few species and low diversity, but high abundances in Oribatida acari.
- The organic system also shows low abundance of springtails, but with high richness and specific diversity.
- The input-economical system presents the highest abundances and diversities of springtails.

Therefore, by using several complementary criteria (abundances, diversity, richness) related to microarthropod biodiversity, we achieve a signature specific to each management model.

INTERESTS AND LIMITS OF THE INDICATOR

+ Ease of implementation and low global cost in routine mode.
+ Multiplicity and complementarity of measurement parameters facilitating interpretation.
– The analysis and interpretation of results require specific expertise. Specialists are however available in most European countries. Some research companies can meet the demand.

Currently

- *UMR UL/INRA 1120, Nancy,*
- *Laboratoire de Zoogéographie, Université Paul Valéry, Montpellier,*
- *Museum d'Histoire Naturelle, Brunoy*
- *Laboratoire Génie Civil et GéoEnvironnement, Université Lille 1*

Publications :

- *Cébron A., Cortet J., Criquet S., Biaz A., Calvert V., Caupert C., Pernin C., Leyval C. (2011). Biological functioning of PAH-polluted and thermal desorption-treated soils assessed by fauna and microbial bioindicators. Research in Microbiology. 162, 896-907;*
- *Cluzeau D., Guernion M., Chaussod R., Martin-Laurent F., Villenave C., Cortet J., Ruiz-Camacho N., Pernin C., Mateille T., Philippot L., Bellido A., Rougé L., Arrouays D., Bispo A., Pérès G. (2012). Integration of biodiversity in soil quality monitoring: Baselines for microbial and soil fauna parameters for different land-use types. Eur. J. Soil Biol. 49, 63-72*
- *Cortet J., Poinsot-Balaguer N., Viaux P., Chabert A., Beaufreton Ch., Cancela da Fonseca J.P. (2002). Impact of agricultural practices on the biodiversity of soil microarthropods: the example of French arable crops. Eur. J. Soil Biol. 38, 239-244.*

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