Caractérisation de la qualité biologique de sols

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OHMi Estarreja
et
OHM Vallée du Rhône

Résumé

Le test lamina bait a été mis en œuvre pour mesurer l'activité alimentaire des organismes présents dans les sols. Les sols choisis ont des origines, des sources de pollution et des caractéristiques différentes à plusieurs niveaux (caractéristiques physico-chimiques, typologiques, pourcentage de M.O.). Nous nous intéressons dans cette étude à 6 sols répartis sur 2 sites différents : 3 sols de typologies différentes prélevés à Estarreja (Portugal) [sol industriel (G), sol de forêt (L), sol de Prairie (K)], et 3 sols de la vallée du Rhône, provenant d'un casier Girardons [correspondant à des temps/structures de dépôts différents Ic, IIb, IIIa]. Sur chaque sol étudié, 60 bandelettes ont été plantées, espacées de 15 cm les unes des autres. Les bandelettes possèdent 16 orifices comblés par un appât (mélange de cellulose, charbon actif et son de blé). Le temps pendant lequel les bandelettes doivent rester dans le sol pour être les plus représentatives possibles de l'activité dépend de nombreux paramètres mais principalement de la teneur en eau présente dans les sols (norme ISO 18311-2016 ; Römbke *et al*., 2006). Nous avons donc choisi de prélever les bandelettes en deux temps : une première moitié 4 semaines après la pose (laps de temps le plus usité dans la littérature, une semaine de plus que ce qui est préconisé dans la norme ISO 18311-2016), la deuxième moitié 2 semaines plus tard. Nous nous sommes ensuite intéressés aux orifices consommés ou non pour en déduire l'activité alimentaire globale du sol. Cette méthode présente les avantages d'être peu couteuse, relativement rapide et facile à mettre en œuvre. Elle ne nous permet toutefois pas de différencier les groupes responsables de cette activité biologique du sol. Plusieurs autres caractéristiques ont été mesurées pour chaque sol, telles que le pourcentage de matière organique ou encore les rapports C/N permettant d'évaluer la capacité de la M.O. à se dégrader dans le sol.

Parallèlement à ce test, nous avons prélevé sur chaque site 3 monolithes de sol (20cm x 20cm x 20cm) que nous avons trié afin d'identifier les organismes vivants et visibles à l'œil nu présents dans les sols (vers de terre, araignées, fourmis, larves, escargots, ...). Il pourrait éventuellement être possible de relier le nombre et la diversité de ces organismes à l'activité alimentaire des sols, ou alors tenter de calculer ce que l'on appelle l'indice biologique de la qualité des sols (IBQS). Pour cela, nous avons commencé par grouper les organismes retrouvés dans les sols selon leur principale fonction dans l'écosystème : (i) Prédateur (araignées, chilopodes, ...), (ii) Décomposeurs (mille-pattes, gastéropodes, ...), (iii) Ingénieurs de l'écosystème (fourmis, vers de terre, ...) et (iv) Phytophages (larves, coléoptères, ...). Le test lamina bait met en évidence une différence notable au niveau de l'activité alimentaire entre les sols des casiers et ceux du Portugal (p-value = 2.10-16). Les activités alimentaires des sols de la vallée du Rhône varient entre 30 et 49 %, tandis que celles du Portugal sont comprises entre 6,4 et 30,1 %. Cette différence se retrouve au niveau du nombre de macro-organismes recensés dans les sols suite à l'extraction dans les monolithes de sol. On constate effectivement que les macro-organismes sont beaucoup plus nombreux dans les sols des casiers que dans ceux du Portugal, ce qui pourrait au moins partiellement expliquer la plus grande activité alimentaire constatée le long du Rhône (il ne faut pas oublier de prendre en compte le rôle des micro-organismes, ce que nous n'avons pas fait lors de cette étude). Les sols des casiers Girardon semblent bien plus propices au développement des organismes vivants que les sols d'Estarreja.

Abstract

The lamina bait test has been implemented to measure the soil organisms feeding activity. The selected soils have different origins, sources of pollution and characteristics at different levels (physicochemical, typological characteristics, percentage of Organic matter). To this study 3 soils with different land uses were collected in Estarreja (Portugal) [an industrial soil (G), a forest soil (L) and a grassland soil (K)] and 3 soils were sampled in the Rhone Valley region, from a Casier Girardon [corresponding to different deposition times / structures, soils Ic, IIb, IIIa]. On each soil, the bait-lamina test was performed and 60 strips were placed vertically into the soil. Each strip contain 16 holes filled with a bait substance (mixture of cellulose, activated carbon and wheat bran). The exposure period for this test depends on many parameters mostly the soil water content (ISO 18311-2016, Römbke *et al.* 2006). The test was performed with two different exposure periods (4 and 6 weeks), being the 4 weeks period the most referred in the literature, and one week more than the recommended in the ISO 18311-2016 standard. The number of full or partially full holes in each strip were recorded and the overall feed activity was evaluated. This method has the advantage of being inexpensive, relatively fast and easy to implement. However, it does not allow to identify the groups that can be responsible for the soil biological activity. Several other characteristics have been measured for each soil, such as the organic matter (%) or the C / N ratios to evaluate the capacity of the OM to be degrade in the soil.

Also in each sampling site, three monoliths (20cm x 20cm x 20cm) were collected and the living organisms visible to the naked eye were identified (earthworms, spiders, ants, larvae, snails, ...). It can be possible to link the number and diversity of these organisms to the soil's feed activity, and/or try to calculate the Biological Soil Quality Index (IBQS). For this purpose, the organisms found in soils were grouped according to their main function in the ecosystem: (i) Predator (spiders, Chilopods, ...), (ii) Decomposers (centipedes, gastropods, ...), (iii) Ecosystem engineers (ants, earthworms, ...) and (iv) Phytophages (larvae, coleoptera, ...).

The lamina bait test showed a significant difference in the level of feed activity between the Casier Girardon soils and those in Estarreja (p-value = 2.10-16) with values of 30 - 49% and 6.4 - 30.1%, respectively. This difference is also found in the number of macroorganisms identified in monoliths. The macro-organisms are much more numerous in Casier Girardon soils than in Estarreja soils, a fact that could partially explain the greater feed activity observed along the Rhône (the role of microorganisms needs to be considered, although it was not done in this study). The Casier Girardon soils seems to be much more favourable to the development of living organisms than the soils of Estarreja.

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Assessment of biological activity in six soils from Estarreja and the Rhône Valley using the bait lamina method

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BACKGROUND

Ecotoxicological tests are used to get informations about substances in the soils and their effetcs on the ecosystems in complement to the chemical analyses. The biological activity of the soils is required to characterize them.
The bait-lamina test is a new way to assessing different functional parameters in soil ecology. The bait lamina test has the advantage of being very simple to implement with little equipment.

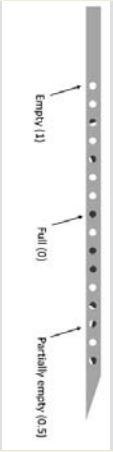
OBJECTIVES

Quantifying the biological activity of the soils, counting the soil organisms and finally indentifying a link between these observations and some properties of this anthropoecosystems was one aim of this study.
The data obtained allowed to complete the soils characterization. A bait lamina test was performed to evaluate the biological activity of the sites. A pre determined amount of soils was collected to count the living organisms.

MATERIALS

The bait-lamina test was performed in 6 sites – 3 in Estarreja (G, K, L), 3 in the Rhône Valley (Ic, IIb, IIIa). Bait lamina are plastic sticks (120 x 6 x 1mm). Each strip contain 16 holes of 1.5mm diameter (5mm apart from each other). The holes are filled with bait substance - mixture of cellulose (70%), bran flakes (27%) and activated coal (3%).

Soil samples (20 x 20 x 20cm) were collected in triplicate on each sites. Organisms in samples have been counted and classified according to their types – phytophagous, decomposers, predators.



METHODS

- The sticks were placed vertically into the soil in a way that the uppermost stick section was just over the soil. We used a knife to make a slit in the soil to put the strips easily.
- 60 sticks were exposed (15cm apart from each other) in each of the six study sites. Therefore we used 360 baits lamina.
- The test was performed with two exposure periods (4 and 6 weeks). At the end of the first period, the half of the sticks were removed from each sites, put in plastic bags and brought to the cold chamber.
- The strips were analysed and the number of full or partially full holes in each strip was recorded. This number gave the percentage of perforated holes by strip.
- The identification of the organisms allows to establish or not a link between the biological activity of the sites and the number of living organisms.

RESULTS

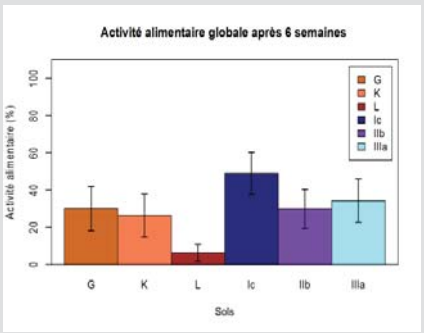
Bait lamina test : biological activity and its evolution with the depth

Pre test

According to the **ISO 18311:2016**, the exposure time depends on the **water content** of the soil studied. The percentage of all filled apertures were measured after **4 and 6 weeks**. **Longer exposure** times **increased** the number of **empty apertures** (generally more than 10%). Based on these observations, we decided to use the lamina exposed during **6 weeks**.

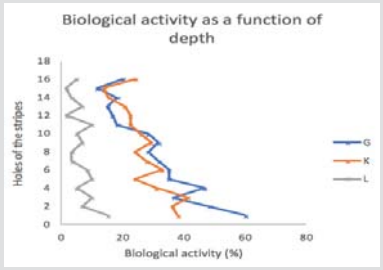
Comparison of the six sites

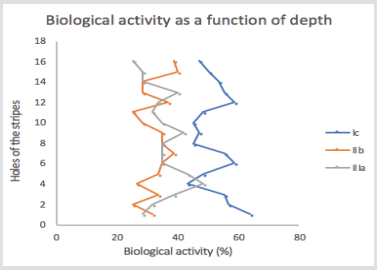
Soils	Biological activity
G	30,1
K	26,4
L	6,4
Ic	49,0
IIb	29,9
IIIa	34,3



- Significant **differences** between the soils from Estarreja and the Rhône valley : p-value = 2.10^{-16}
- **Higher values** in the soils from the **Rhône valley**

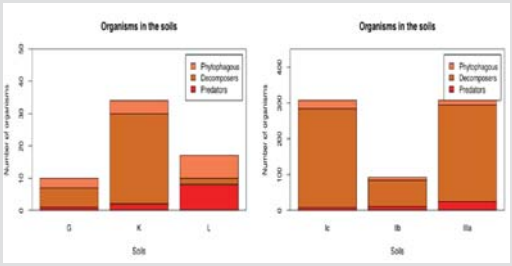
Evolution of the biological activity with the depth





The **biological activity is higher close to the top surface**. It **decreases** with the **depth**. This is shown most clearly by the example of the soils from Estarreja. The distribution of feeding activity along the depth is different between Estarreja and the Rhône valley. Relations between feeding activities and macrofauna were expected (Römbke *et al.*, 2006). The data on macrofauna abundace are presented after.

Organisms into the soils



Results about the number of organisms into the soils follow the **same pattern as the biological activity**. Higher values are in the soils of the Rhône valley, particularly in the soil Ic.

CONCLUSION

Biological activity of 6 soils was studied and coupled to the macrofauna abundance. Feeding activities of soil organisms was higher in the Rhône valley. The distribution activity is different not only between the site but also along the depth.

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