Protocol Group 1: Soil Microfauna as Bioindicator

Introduction

Soil Fauna are those organisms that inhabit the soil. They include arthropods, nematodes, molluscs, protozoa (testate amoeba), rotifera, enchytraeids, tardigrades. These soil animals and its community help in soil formation through distribution of organic matter and nutrient cycling and many other processes which help in soil restoration. Unfortunately, soil fauna is poorly monitored even though it represents a good tool to access the soil quality (Menta et al, 2014).

Human activities like mining, farming and exploitation of other biological resources from the soil leads to loss of soil structure and function, reduction in biodiversity, habitat fragmentation, nutrient cycling and organic matter destruction. A combination of those factors can lead to ecosystem destruction. Soil arthropod communities are highly sensitive to environmental variation and destabilization, thus they are valuable indicator to reflect variation of environment and basic condition of the ecosystem. Van Straalen, (1997) and Zhang et al (2014) reported the various research projects which were conducted on the soil environment using soil fauna as a bio-indicator.

These living organisms in the soil can provide valuable information on the state or conditions of the soil. However, it is still hard to draw a definite conclusion on how the variation of diversity of soil fauna influences the function of the ecosystem, mostly because of limited research methods and techniques.

Soil fauna which includes meso-micro-arthropod groups are a useful bio-indicators for human disturbance and has been used to define the ecological state of a mine site in Northern Brazil (Zeppellini et al, 2009). Bio-indicators like termites and ants are important soil movers just like earthworms, which are considered ecosystem engineers. These soil animals are evaluated and assessed to know the biological activity of the soil they inhabited using various sampling techniques like the flotation technique, litter bags, pit-fall traps, hand sorting, Macfadyen extraction, Tullgren extraction or eclector traps. One of the commonly used traps used to sample litter and surface dwelling arthropods are pit-fall traps (Mikhail, 1993).

Pitfall traps catch arthropods which fall into cups filled with preservatives and, being highly effective, it provides comparable estimates of the soil arthropod communities. The idea behind soil fauna and using pit-fall traps as a sampling technique to assess soil conditions is that in the conducted experiment the assumption was that there would be a greater biological activity of plant, animal and microbial organisms interactions in viable soils and that an ecological rich or poor nutrient soil will harbor large amount of organisms or lack of it, mostly meso-micro arthropods and, so the concept of indicator organisms (bio-indicators) or indicator communities which are captured in the traps will be used to determine the soil condition .

In this study, the aim was to evaluate the conditions of selected studied sites at the Ulm University botanical garden and being able to compare the abundances of different indicator species in different types of biotopes, using pit-fall traps as a sampling method.

Materials and methods

The study was carried out in Botanical Garden in Ulm. There were three investigated sites: mixed forest, field and grassland. Ground traps were used for catching soil organisms. The sampling was done over 10 days, from 4^{th} to 14^{th} September.

The traps used consisted of a plastic cup, which was embedded in the ground, preservation fluid and a yellow plastic roof (a few centimetres in height) to keep rainfall from filling the cups. They resembled the Barber´s type rather than the pitfall type because of the lack of a tube, in which the cup is situated in a classical pitfall trap. The preservation fluid consisted of alcohol, water, acetic acid and a detergent which helps to eliminate the surface tension of the fluid. This way even very light animals sink into the fluid.

At each site 3 traps were placed, about 5 – 10 m from each other. It was also necessary to avoid an edge effect, e.g. with enough distance to the outskirts of the forest.

After 10 days the samples were collected and the individuals of the soil fauna were identified (until order level) and counted. After that, the numbers of soil animals were compared.

Results

In nearly all pitfall traps there was a mass of flies conserved. But as adult flies cannot be counted as soil organisms and were so numerous that they made a clear display of results rather difficult, their numbers have been left out in all following figures and descriptions of results.

In the mixed forest, a high amount of mites (nearly 40) was found, as well as a high number of ants (cf. fig. 1). Also, the only harvestman found was caught in the forest site. The ground beetles that were trapped in this site were extremely big in comparison to the ones found in other sites.

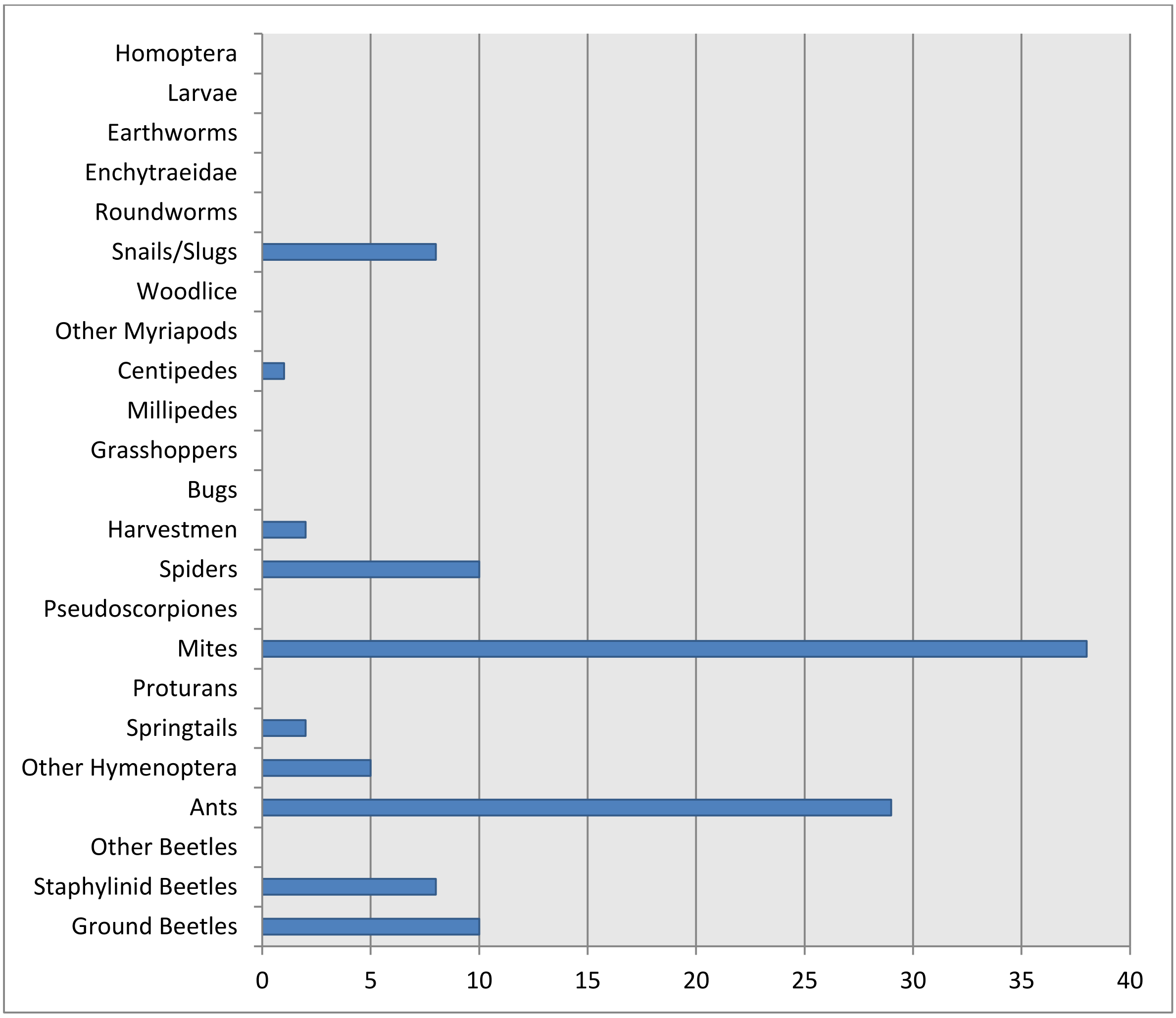

Figure 1: Numbers of individuals counted in the forest site (excluding flies)

The first striking discovery in the traps on the field site was that mice had been trapped in two of three pitfall traps. Apart from that, a very high quantity of ground beetles and spiders could be found, whereas mites, ants and other beetles were not as numerous (see fig. 2).

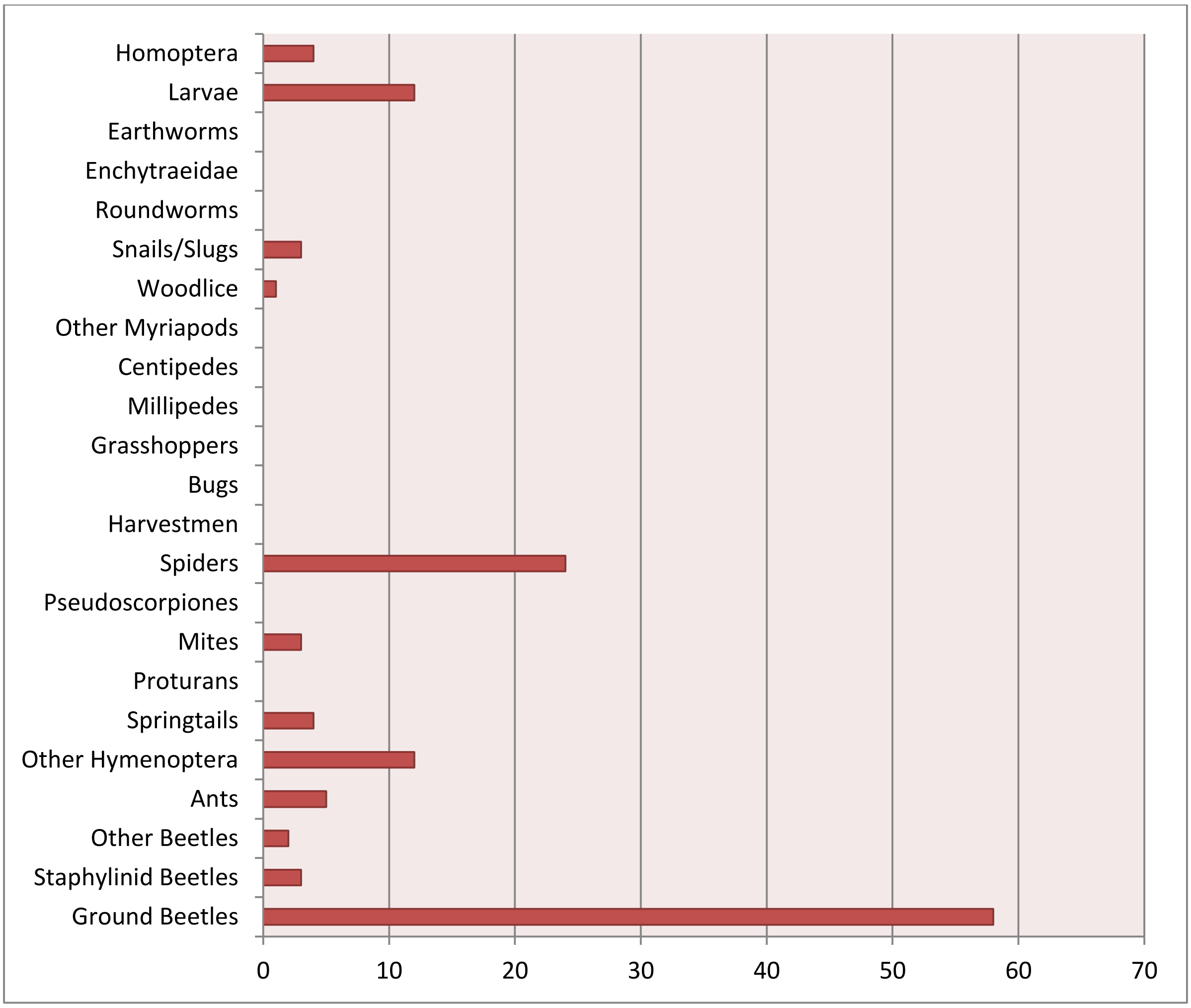

Figure 2: Numbers of individuals counted in the field site (excluding flies)

In the grassland site, as can be seen in figure 3, multiple taxa were present with quite high numbers of individuals: Ants, spiders and diverse larvae as well as staphylinid and ground beetles could be found. Additionally, nearly 30 springtails were counted.

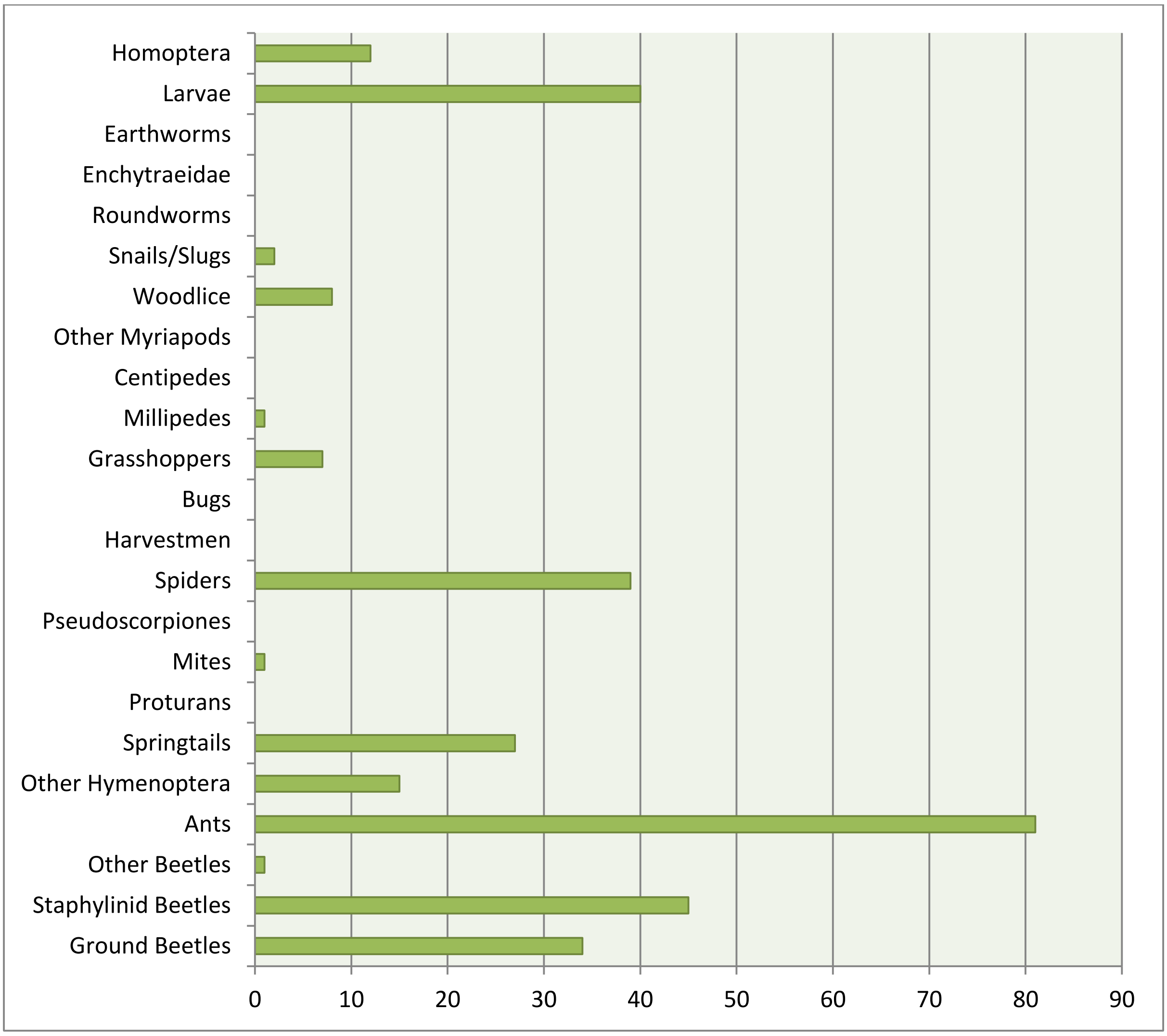

Figure 3: Numbers of individuals counted in the grassland site (excluding flies)

In figure 4, a comparison of the individual quantities of different taxa in all three sites is given.

One noticeable fact is that the quantity of ground beetles in the field was the highest in all capturing sites, directly followed by the grassland. The beetles found in these two areas were a lot smaller than the strikingly big ones in the forest. When it comes to the staphylinid beetles, the number of caught individuals in the grassland site was extremely high compared to forest and field, although the amount in the forest itself was still relatively high.

Whereas the abundance of mites in grassland and field was very low, it was extremely high in the forest site.

Comparing the numbers of springtails and ants, the highest numbers for both were found in the grassland, but the smallest amount of springtails could be observed in the forest and the smallest amount of ants in the field.
Slugs and other hymenoptera could be found in all sites, but larvae (especially highly abundant in the grassland) and other beetles were only caught in field and grassland.

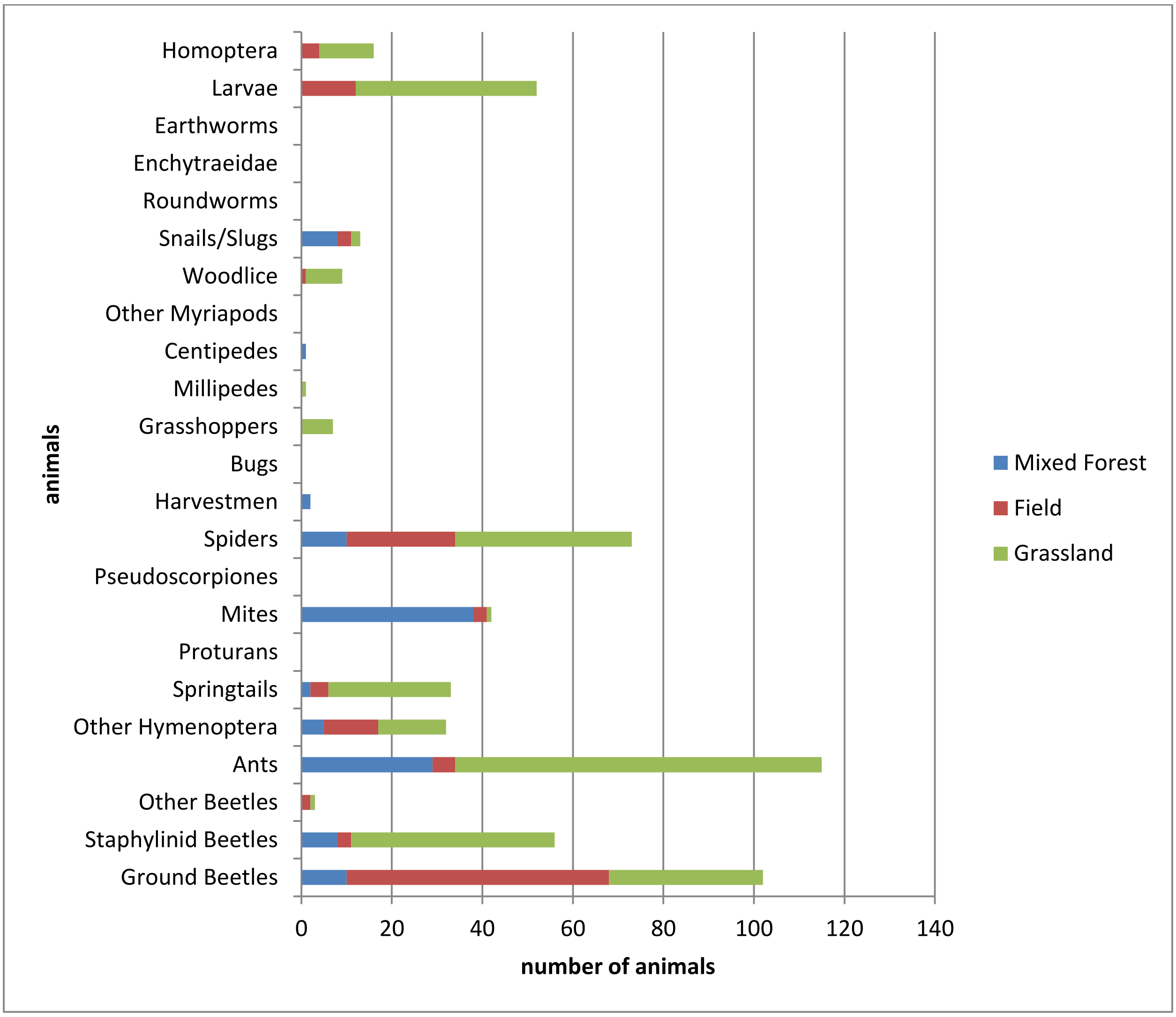

Figure 4: Comparison of all numbers of individuals counted in all three sites (excluding flies)

Discussion

At first it has to be said that the number of samples taken was too low to perform statistical analysis on them and therefore to make any statistically significant and relevant statements about the results. This experiment would have to be performed once more, with a much greater number of samples and additional sets over a longer time period.

Also, some parts of the construction of the pitfall traps may have altered the results. First of all, a cover was used, so either its colour or the fact that it might have heated up the microclimate underneath it could have attracted some species more than others. The yellow colour for example could look like a flower to some insects. Apart from that the preservation fluid is always a point of discussion, because its smell and compounding might act as a repellant or even attractant to special animals (e.g. the acidic, vinegar-like smell of the used fluid as a potential attractant to flies).

Also, because the used traps were not constructed like classic pitfall traps with a tube to put the vessel in, but more like a Barber trap type, we experienced digging-in-effects. The smell of freshly dug-up soil influences the abundance of especially attracted animals.

One major reason for the amount of flies and other beetles (which were in fact mostly burying beetles) in the field was that there was no grid on top of the catching vessels. This allowed mice to get trapped inside and the dead carcasses acted as attractants for burying beetles. However, the grid was not used out of the reason that some beetles or bugs are able to balance along the grid instead of falling off into the traps.

In the forest site, some potential bioindicators could be found in quite high abundances, most importantly staphylinid and ground beetles, also ants and a high number of mites. Concerning the ground beetles, a comparison of the biomass between the different sites should be conducted in order to be able to compare them correctly. This is because the forest beetles were not as numerous as those in the grassland or field, but their size was considerably bigger. So the evaluation of the numbers of beetles (staphylinid as well as ground) as a bioindicator is not really possible for this experiment.

Ants (which were highly abundant in forest and grassland) might also be considered as bioindicators, as they influence a lot of other organisms, but their behaviour makes the analysis of the results of an experiment using pitfall traps also quite hard: Ants move in special patterns, on fixed ant 'roads', so the high numbers of ants caught could be caused just by the ants' behaviour instead of special ecological reasons.

Lastly a large variety of the numbers of mites could be observed on the different sites, but mites are not very suitable as bioindicators because they are very robust and durable when it comes to pollution of their environment (Huguier et al., 2014).

When looking upon all results, comparing numbers and trying to say something about the quality or the state of the different ecosystems in the Botanical Garden one conclusion has to be drawn: That this is not possible only comparing numbers of individuals judging by their orders. Bioindication can only be evaluated on a species level and with detailed knowledge about environmental and ecological preferences and requirements of the species.
But after looking at all results, an overall conclusion can be drawn from them: The Botanical Garden of the Ulm University, despite being a man-made environment and therefore artificial habitat, still functions as a biotope that closely resembles natural conditions and allows certain organisms and ecosystems to work nearly like under completely natural conditions.

References

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