DAILY REPORT 21/09/2012 Kadri Krebstein, Franck Coudray, Diego Sánchez de Cima

8:30 – 10:00 Effect of stress and disturbance on soils. Organic matter recycling (Baldy)

Soil can be considered as a medium for plant growth, as a recycling system, as a water supply and purification, as a habitat, as an engineering medium, etc.

Among the different horizons present within the soil profile, organic horizons occupy the upper layers of it. These organic horizons constitute the humus layers. Therefore from top to bottom it is possible to find different organic soil horizons: non-fragmented leaves (OL), organic layer including faunal faeces (OH), organo-mineral layer (E or A). These superficial horizons are the most active in a food web and flow of energy perspective. From the decomposition process depends the soil quality and fertility. This leaf litter decomposition is a key process for ecosystem functioning, and it's mainly a biological process.

There is a lack of data about the C sequestration in humus.

Fragmentations and mixing of the horizons create physical and chemical modifications. As a result, humification and mineralization processes occur.

This decomposition process is carried out by different groups including fungi, bacteria, insects, arthropods, etc. According to their respective size, it is possible to distinguish among: microfauna (<0.2 mm, nematodes and protozoa), mesofauna (0.2-4 mm, microarthropods and others), macrofauna (> 4mm).

Some of the organisms important for the organic matter decomposition are described below:

Enchytreids (1-5 mm): white small worms feed on soft leaves part living in the OL, OF. Their fecal pellets constitute the mentioned OH horizon.

Earthworms (>5 cm) *Lumbricidae*. In one ha of soil, 2 tons of earthworms can be found. They are considered anecic (they move between horizons). Further than the mixing of horizons, earthworms play an important role because their castings which contains 16 times more N and 30 times more P than the soil itself.

In this organic profile is also possible to find smaller epigeous earthworms (they remain in top soil layers being possible to find them in OF or OH horizons).

Collembola: microarthropods without wings which can be used as bioindicators of the soil quality (in 1 m^2 we can find > 200.000 collembola).

Acaria (microarthropods). In one 1 m^2 forest soil it is possible to find more than 250.000 individuals. Collembola and Acaria decompose litter from OL and OF horizons and accumulate fecal pellets in OH.

Microorganisms (bacteria and fungi). They play a key role in litter decomposition, being able to mineralize organic matter (C, P, N, cations, etc.).

Leaf litter decomposition is controlled by:

a) Leaf litter chemistry (structure and defense compounds, nutrients)
b) Environmental conditions (i.e. water content)

For studying litter decomposition, litter bags in situ approach method is used. With mesh size depending on the fauna we wanted to study. We put a certain amount of litter in net bags. Some of the litter bags were retrieved from the field at regular intervals. We determine leaf mass loss during decomposition, and decomposers associated to decomposed leaves, by means of biomass and diversity measurements

Methods for studying the mesofauna:

- Berlese funnel mesofauna extraction. Based on the principle that mesofauna escape s from dry litter and fall down to an alcohol solution. After extraction, organisms are counted and identified.
- Ergosterol is a fungal biomass indicator: extraction, purification and quantification by HPLC
- Microbial catabolic profiles associated to decomposed leaves (based in color changed related to degradation capacity) are also used due to optical density is proportional to degradation capacity of the organism.
- Litter secondary metabolites dynamics: terpenoids and phenolics extraction (chromatography and spectrometry).

Do stress and disturbance affect leaf litter decomposition?

Mediterranean terrestrial ecosystem is characterized by a climate with a hot and dry summer, low annual rainfall, violent rainy and windy events, recurrent fires, sols often shallow, and a old anthropogenic pressure. These ecosystems are colonized by plants adapted to these stressed conditions, with special morphology (as scleprophyllous plants are dominant) and special physiology as these plants are producing large amount and diversity of secondary compounds.

Water stress affects to litter decomposition: dry period fungal biomass development is almost stopped and therefore decomposition is almost stopped. There is a positive linear relation between litter humidity and litter fungal biomass, and this is also visible in the number of individuals of mesofauna which is increased in humid seasons. Mesofauna colonization occurs later than fungi colonization since mesofauna needs fungi to start the process.

In the temperate forest, we observed a continuous dynamics for leaf mass loss and decomposers

On the opposite, in the shrubland, we observed a discontinuous dynamics, depending on drought periods.

Compost amendments on Mediterranean soils is a suitable technic for accelerating the natural recovery process of soils degraded by recurrent fires, by increasing soil fertility. Although, sludge compost contains high quantity of P which can represent an environmental problem.

Compost amendment increases leaf nutrients content but does not affect litter decomposition, fungal biomass and abundance of microarthropods associated with litter. It helps the plants to survive during dry period because it contains more water than soil.

10:30 – 12:00 & 13:30 – 14:15 Abiotic stress in forest (Niinemets):

Water is crucial component for life, especially in plants where constitutes the 50-90% of their mass. Otherwise not all the parts of the plant have the same amount of water. For instance seeds have not so much water content in other to prevent of enzymatic reactions, due to the most of enzymatic reactions take place in presence of water.

Stomata pores are one of the responsible organs in the regulation of the amount of water losses. Species like mosses with a lack of them are totally dependent of water presence, but they have a high toleration to desiccation.

Vacuole, generally one and with bigger size in plants than animals, maintain stable cellular ion and solute concentrations.

Succulent plants present another adaptation, a high water content buffer, meanwhile other plants are adapted to salty soils.

Plant photosynthesis present a bell shape response, with an optimum point but normally plants in natural environments are subjected to stress, defined as any external influence that constraint specific plant processes. This stress is translated into a reduction of activity and creates a stress response: acclimation which takes place within the species lifetime (phenotypic changes) and adaptation (genotypic changes).

But also plants are subjected to biotic stresses caused by pathogens, infections, diseases, competition, herbivores, etc.

Among the abiotic stress sources we distinguish: temperature, water (drought and flooding) radiation (light availability), chemical influences (pollutants, excess of different minerals), mechanical influences (wind, surface movement), other (electric field, magnetic field)…

Stress in trees

The capacity of fixing C by the plants is affected by the light level or light leaf exposition decreasing and hydraulic conductivity. As response of low or high light exposition levels, plants develop several characteristics modifying its physiognomy, but this fact is intimately linked with other changes affecting the amount of absorb water (i.e. low sunlight levels → promotes the development of bigger leaf surface).

Light can be a limiting factor for plant growth but plants are not able to use all the amount of light they perceive (500-700 $\mu mol.m^{-2}.s^{-1}$). In higher elevations there are more photo inhibition.

For measure the stress non destructive (spectral index, remote sending, visual degree of damage …) and destructive methods (measure of drought, chemical estimation composition, gene expression …) are used.

In stress situations, there is always a point of no return, which means after the stress the plant cannot be adapted anymore.

Some stress promotes the production of stress hormones and volatiles.

Within the abiotic stress factors we can consider: water stress (draught or flooding), anoxic conditions, nutrients, excess light, mechanical stress…. But forests are also affected by changes in light, wind, absence or low water retention (sandy soils), etc. Also abiotic factors are responsible of global changes such like global warming (more pronounced in north altitudes where are concentrated the highest amount of continental land).

As it has been said, forest as ecosystem need to response to multi-stress draught and irradiance situations. High light levels require high index of water (stomata openness is linked to light/water conditions, being closer in the upper canopy). When the stomata are closed in their majority, there is a loss of productivity. Also and directly related with light stress condition, heat stress affects to plant gas exchange.

<u>Stress tolerance</u>: is the capacity of certain plant species to endure the influence of certain stress level; in limiting conditions of light or O_2, two different metabolic routs can take place: Krebs route (in presence of O_2, more energetic: 1 mol glucose = 36 mol ATP) or fermentation (in absence of O_2, less energetic: 1 mol glucose = 2 mol ATP).

In the case of limiting water plant tend to develop strong leaves, limited light increase the light harvesting efficiency, increase the leaf biomass, etc.

14:15 – 15:00 Interactions in plant-soil-systems (Astover)

There is a dual affection between plant and soil, but without soil plants can exist (they are necessary for the organic matter formation), but not vice versa if we consider the soil as medium where plants can be developed, but what they need is the nutrients, water and suitable conditions for root development.

These nutrients are absorbed by roots as ions from the sol water or solution by diffusion, mass flow, and root interception; but also exist other way of “nutrient supply-taken” such like foliar uptake, and mycorrhizal symbiosis (80% plants can form them) where plants can take an 80% of N and 90% of P.

Nutrients have mobility within the soil but also within the plant. According to this we classify them in:

High mobility nutrients like NO^{3-}, sulfate S, B; moderate mobility nutrients: NH4+, K, Ca, Mg, Mo; and immobile nutrients: P, Cu, Fe, Mn, Zn.

In the case of nutrient mobility in plants: Ca is not moving along the plant. And in the other hand N,P, K, and Mg are very mobile.

Nutrient availability is dependent on pH. A curious example is the case of some species of hortensia (*Hydrangea*), which can vary its color according with the pH and Al availability (in acid conditions Al is more availability and blue color).

There is an optimal level of nutrients too. Below this optimal nutrient cadences can occur and over it excess situations can occur (toxicity). For example in cereals an excess of N can provoke lodging. In the case of other crops like potato higher quantities of nutrients (i.e. manure) are needed for preserving its yield in time.

Other cultures such as crop rotation affects to the content of soil lactate content to soil lactate. Depends also of the plant (different availability level) some grasses are able to take more than 20% of the P in one year, also Leys and Rye. In the case of K, grasses 40%, Leys too and followed by potato. Problem org farming, there is a limiting possibility of putting back nutrients in soil if there is a high ha of grasslands (problem in long term)

Soil science USA proverb: *Soil is like a bank*.

What is the good indicator of soil quality: Productivity? Biodiversity?....

15:30 – 17:00 Seminars related to plant stress

Combined effects of elevated CO2 and natural climatic variation on leaf spot diseases of redbud and sweetgum trees.