P7-06 Phenotypic plasticity of maritime pine to insect herbivory

Rafael ZAS[1], Xoaquín MOREIRA[2] and Luis SAMPEDRO[2]

[1]Misión Biológica de Galicia (MBG). CSIC. C/ Carballeira, 8. Salcedo 36143 Pontevedra, rzas@mbg.cesga.es
[2]Centro de Investigación Forestal de Lourizán, UA-CSIC, Aptdo 127, 36080 Pontevedra, lsampe@uvigo.es

Plants are able to recognize the biotic damage caused by insects or other plant enemies, and quickly react activating a suit of plastic responses that strongly enhance plant resistance (i.e. reducing further damage) and/or tolerance (i.e. reducing the impact of damage on plant fitness). During the last decades large progress has been made to understand the molecular mechanisms involved in the recognition, triggering and signalling of plant induced responses. We now know that plastic responses to herbivory are much more complicated, variable and widespread than usually assumed. They include a wide range of physiological and morphological changes, from the simple increase of the concentration of existing chemical defences or the production of new physical or chemical barriers, to other much more complex mechanisms that even involve other members of the ecosystem. Plants are able, for example, to detect alarm messages emitted by neighbouring damaged plants, and prepare their physiological machinery accordingly to the increased risk of damage. The volatile organic compounds emitted by damaged plants can also serve as cues for herbivory enemies that can help the plant by reducing herbivore populations within complex and exciting tritrophic interactions. The presence of mychorrizas and other microorganisms of the rizhosphere may also play key roles modulating the efficiency of the induced responses. Most of these fascinating responses, which constitute a kind of plant immune system, have been demonstrated only in annual model plants, but we still know little about defensive induced responses in long-lived plant species such as pines. Pines are large, long-lived plants that are particularly exposed to herbivory. Because they have to fight against many types of different herbivores that may exert highly variable pressures during their long-life span and, at the same time, keep growing and reproducing, defensive strategies based on plastic responses may be even more effective in these species.

In this communication we summarize recent results on the plastic responses of maritime pine (*Pinus pinaster* Ait.) to real or simulated herbivory. As expected, maritime pine seedlings strongly react to insect herbivory, increasing the concentration of chemical defences (resin and phenolics) and modifying the profile of both resin terpenes in plant tissues and volatile terpenes emitted from the needles, changes that may be involved in plant-plant or plant-animal communication. The responses can be extremely strong and fast, with up to 3-fold increase of the resin content in the stems within just 48 hours of insect feeding.

The induced responses of pines trees are not restricted to the site of injury; instead, they can be detected further away, especially in those tissues more relevant for plant fitness (e.g. primary meristematic tissues). Induced plastic responses also involve permanent anatomic changes such as the formation of new traumatic resin ducts that helps improving plant protection systemically. Responses to herbivory do not only include changes related to secondary metabolism but also relevant changes in carbon and nutrient allocation within the plant, as well as alterations of primary and secondary growth patterns. For example, after application of methyl jasmonate, a phytohormone involved in signalling insect damage and triggering induced responses, we found a huge increase in the biomass of the fine root fraction and significant shifts in nutrient allocation from roots to shoots. Both increased nutrient acquisition and nutrient reallocation will likely help to reduce the impact of the damage on pine fitness, and thus are interpreted as "induced tolerance" responses.

All these plastic responses show different levels of genetic control within the studied populations, and are modulated by abiotic environmental conditions, such as nutrient availability, offering a fascinating scenario to study the relevance of pine defensive strategies within the evolutionary ecology of Mediterranean pines.