Multitrophic behaviour of fungal parasites of invertebrates: clues in their biology, genomes and other "omics"

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Nematophagous (NF) and Entomopathogenic fungi (EF) infect invertebrate hosts (nematodes and insects) which cause directly or indirectly (usually as vectors) important pathologies (with associated enormous economic losses) in both plant and animal hosts. NF and EF have therefore a direct application as biological control agents in sustainable agriculture. Nematodes and insects are also a health hazard since they can also affect animal hosts (including humans) directly or as vectors of disease agents. In this way NF and EF are also useful for controlling animal parasitic nematodes or insects.

NF and EF are usually not obligate pathogens. This means that they can have, apart from nematodes and insects which we call their canonical or "normal" hosts, other non-canonical o alternative hosts. NF and EF can, for instance, colonise plants (mono and dicots) acting as endophytes. As endophytes NF and EF modify plant physiology and development by modulating their defences and promoting growth. Plant response to biocontrol fungi just like for pathogens depends both on the species of both partners. Our group is currently exploring using metabolomics[1] the signals involved in the multitrophic interactions of plants, nematodes and NF. This topic is important for the application of biocontrol fungi as plant inoculants. Consequently NF and EF have also a role in plant health independently of the presence of pest or disease causing agents.

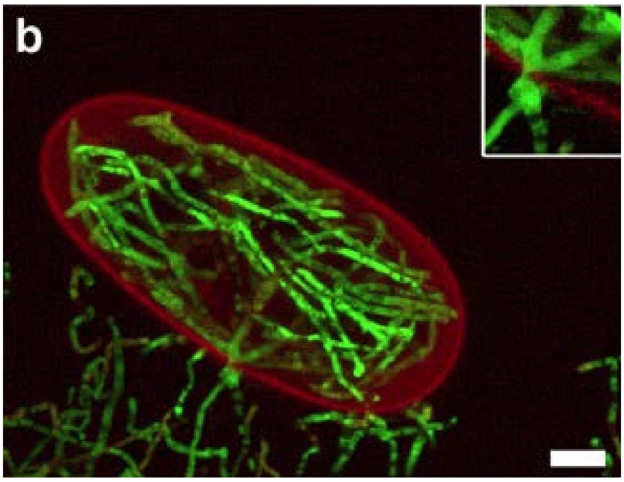
When infecting their canonical hosts NF and EF must degrade their barriers (eg. egg-shells/cuticles). Chitin is a main structural component of these barriers. Its deacetylated form, chitosan, has higher solubility and is known to have interesting biological properties. Chitosan permeabilises the membrane of plant and human fungal pathogens killing them or compromising their growth. On the contrary NF and EF are resistant to chitosan. Chitosan in both NF and EF activates fungus development and expression of pathogenicity factors such as proteases involved in degradation of host barriers. In our group we are using molecular, cell and agronomical approaches to understand the multimodal action of EF, NF and chitosan to fully exploit it in sustainable agriculture and health applications.

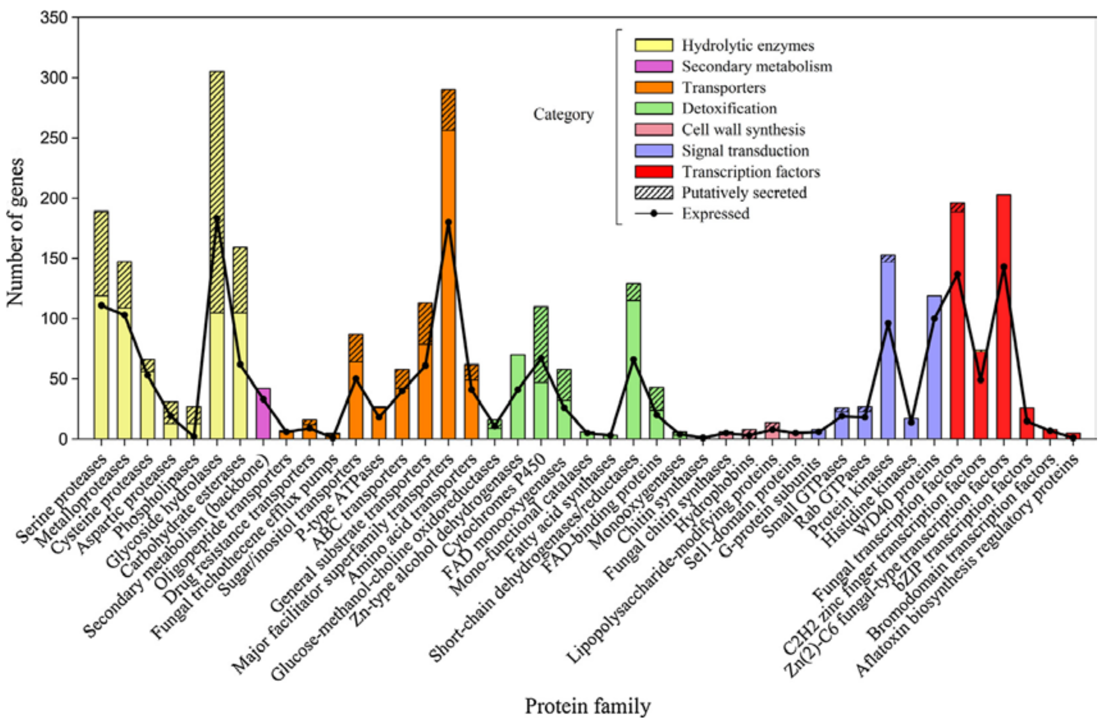
We have recently sequenced the genome of the NF *Pochonia chlamydosporia*[2]. This has lead us to gain a better understanding of the multitrophic behaviour of this biocontrol agent. A phylogenomic analysis showed, for instance, that the genome of the fungus is closest to that of EF but it is also related to that of fungal plant pathogens. This could explain the endophytic behaviour of both NF and EF. Besides, the gene families of hydrolases, especially proteases and glycosylases, with members involved in the depolymerisation of key components of eggs shells and cuticles of nematodes and insects but also of cell walls of plants and fungi, are highly expanded in the genome of *P. chlamydosporia*. Secondary metabolite gene clusters (encoding toxins and other active compounds) are also well represented in *P. chlamydosporia*. Functional genomics will help in future studies to understand and perhaps modulate gene functions (not necessarily by genetic engineering) to improve the behaviour of *P. chlamydosporia* and similiar fungi as versatile biocontrol agents with a key role also in improving plant adaptation, plant defence and crop production. This will be of key importance in a scenario of global change.

[1]Escudero et al. 2014. Metabolomics. DOI 10.1007/s11306-014-0632-3.

[2]Larriba et al. 2014. Fungal Genetics and Biology DOI: 10.1016/j.fgb.2014.02.002.

Fotos: Huevo de nematodo infectado por el hongo *P. chlamydosporia* (cepa transformada con la GFP) y familias de proteínas en el genoma del hongo





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Prof. **Luis V. López-Llorca**, is full Professor at the Universidad de Alicante. He has been teaching at undergraduate and post-graduate courses in Botany, Mycology, Plant Pathology and Marine Biology. He has. He has more than twenty years research experience in Spain, the Netherlands, UK (where he got his PhD), USA and Canada on the mode of action (including molecular work), ecology, and practical development of biocontrol fungi. He studied the involvement of proteases and chitinases in the infection processes of parasites of nematode eggs. He has also investigated microscopically the mode of infection of nematophagous fungi in the plant and the nematode hosts and developed methods for production and formulation of biocontrol fungi based on plant waste products. He has also a wide experience in the mode of action of fungal pathogens especially from palms. He has cooperated with scientists in Europe, USA and Central America participating in circa 20 research projects financed by Spanish, European and North American official and private funding agencies and companies. He has published more than 80 scientific papers, including invited review articles, and 9 books and book chapters. He is also member of several scientific societies and has organized symposia and courses (in Spain and abroad) in the disciplines of his specialty. He has been called as scientific advisor by the EU, has reviewed scientic papers and project applications. Prof. Lopez-Llorca has also been a member for MSc, PhD and University lecturer evaluation boards.

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