Internship topic / IMPLANTEUS M2 2021

Assessing the epidemiological risk to crops in the PACA region from the ubiquitous populations of *Pseudomonas syringae* in the Durance River

Dates: 1 March to 31 Aug 2021

Research Team: the MISTRAL team, INRAE, Plant Pathology Research Unit, Montfavet
https://www6.paca.inrae.fr/pathologie_vegetale_eng/Contact-us/Mistral-team

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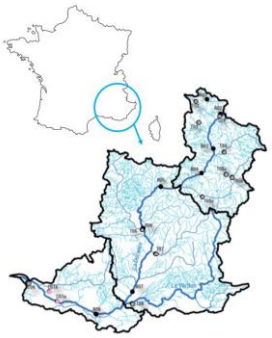
Context



The framework for understanding disease epidemiology, for epidemiological surveillance and disease forecasting, and for managing human habitats to control diseases of humans and domestic animals has shifted dramatically over the past decades. This change is manifest in the emergence of the One Health concept that takes into consideration the abundant reservoirs of human pathogens outside of human habitats and the role of these reservoirs in disease epidemics [Hincliff 2015]. In contrast, the study of plant disease epidemiology is still very agrocentric and has not really set disease cycles and management in a holistic environmental scope in spite of the longstanding influence of ecological concepts (*viz.* Agroecology, Integrated Pest Management). For over a decade, the MISTRAL team at INRAE in Montfavet has worked to build a new epidemiological framework for plant disease by finding reservoirs of pathogens outside the frontiers of crop production and by providing evidence for natural, long distance dissemination (via wind and surface waters, in particular) that can bring microorganisms into cropped regions from elsewhere.

The bacterium *Pseudomonas syringae* is one of the pathogens for which there is now ample evidence for the multitude of reservoirs outside of agricultural contexts [Morris et al. 2013]. *P. syringae* is one of the most frequent causes of new emergences of plant diseases, on a range of fruit and vegetable crops [Lamichhane et al. 2014, 2015; Morris et al 2019]. It is also easy to detect in freshwaters, including lakes and rivers that are used for irrigation. In an ongoing project in the MISTRAL team, we have shown that *P. syringae* is present in the Durance River along 21 sites from the river source to the plains near Avignon, where it flows into the Rhone River, at all times of the year [ANR project SPREE: shorturl.at/wLVZ5]. Waters from the Durance River are used for irrigation on a wide range of crops Therefore, it is important to assess the epidemic potential of strains of *P. syringae* that would encounter crops during irrigation.

Scientific objectives

- Establish a set of criteria to estimate the phytopathogenic potential of strains of *P. syringae* isolated from river water.
- Determine which strains, according to their phylogenetic context and phenotypic traits, pose the greatest risk for crops in the Durance watershed.
- Assess the possibility that phytopathogenic potential of *P. syringae* is related to the capacity of this bacterium to survive/multiply in river water.

Resources

- A comprehensive bibliographic database on *P. syringae*
- Data on host range and various biological traits of hundreds of strains of *P. syringae* from published and non-published results from the MISTRAL team
- A collection of thousands of strains of *P. syringae*
- Data on the phylogenetic context of hundreds of strains and thousands of isolates (to be purified) of *P. syringae* in the collection of the MISTRAL team. Whole genome sequences of hundreds of strains of *P. syringae* (some of which are in the collection of the MISTRAL team)
- Data on land use in the PACA region and about the major crops.
- Data on the abundance of *P. syringae* in the Durance River across seasons and data on the phylogenetic diversity of these populations.
- Laboratory, greenhouse and growth chamber facilities for characterization of host range and other biological traits and for molecular characterization if needed.

Tasks

- Conduct a literature review on how the pathogenic potential of microorganisms is evaluated for pathogens of humans, animals and plants. Write a summary of the information as the introduction to the final report for the internship.
- Based on previous data about the host range of *P. syringae* and on the literature about estimating pathogenic potential, establish a set of criteria that can be used to estimate pathogenic potential (the "epidemic indicator") of strains. These criteria will be used for tests in the laboratory to characterize strains from the Durance River. Based on previous results, it is most likely that these criteria will include the phylogenetic context of the strains as well as various biological traits and metabolic processes.
- Choose a set of strains of unknown pathogenic potential from the Durance River (from the collection of strains established by the MISTRAL team) for which you will evaluate the "epidemic indicator". Choose a set of reference strains of known epidemic potential to assess the accuracy of the "epidemic indicator".
- Evaluate the accuracy of the "epidemic indicator" by comparing the traits of strains from river water to those of strains with known epidemiological importance. Achieve this via tests in the laboratory to characterize strains and via statistical analyses of the results. Determine what adjustments to the indicator would be useful.
- If there is sufficient time, participate in an ongoing study in the MISTRAL team to evaluate the fitness of *P. syringae* in river water. Determine if there is a correlation between the epidemic potential of strains of *P. syringae* and its fitness or capacity to survive in river water.

Literature

- Hinchliffe, S. 2015. More than one world, more than one health: Re-configuring interspecies health, *Social Science & Medicine*, 129, pp. 28–35. doi: https://doi.org/10.1016/j.socscimed.2014.07.007.
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- Lamichhane J.R., Varvaro L., Audergon J.M., Parisi, L., Morris C.E. 2014. Disease and frost damage of woody plants caused by *Pseudomonas syringe*: seeing the forest for the trees. In: Sparks, D.L. (ed.), *Advances in Agronomy, Academic Press* 126:235-295.
- Morris C.E., Lamichhane J.R., Nikolić, I., Stanković S., Moury B. 2019. The overlapping continuum of host range among strains in the *Pseudomonas syringae* complex. *BMC Phytopathology Research* 1 :4 doi.org/10.1186/s42483-018-0010-6
- Morris C.E., Monteil C.L., Berge O. 2013. The life history of *Pseudomonas syringae*: linking agriculture to Earth system processes. *Annu. Rev. Phytopath.* 51:85-104.