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THE ABUNDANCE AND DIVERSITY OF *PSEUDOMONAS SYRINGAE* IN THE DURANCE RIVER THROUGH A WATERSHED IN A MEDITERRANEAN FRUIT AND VEGETABLE PRODUCTION REGION

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RIVERS, CROP IRRIGATION & PLANT PATHOGENS

River waters are widely used for irrigation including in southeastern France where 27% of France's horticultural crop-producers and 21% of its fruit orchardists are located. The Durance River - exploited since the 1100's for irrigation, milling, navigation, drinking water, mining of sediment, generation of electricity and recreation involving the creation of canals and dams, restructuration of banks and dredging of sediments - drains over 14000 km² of which 20% is agricultural production. *Pseudomonas syringae* has been isolated from the Durance and other rivers throughout the world, leading to questions about the link between irrigation and disease outbreaks [1].



An irrigation canal in southeastern France.



Durance River basin in southeastern France.

DO *P. SYRINGAE* POPULATION SIZES VARY IN THE BASIN ?

In an ongoing project [2], we examined if populations of *P. syringae* are homogenous along the full length of the river. They could be affected by land use and seasonal changes in water flow. Ground cover and land use in the Durance River basin are influenced by topography. Recreation, pastures and nature reserves dominate the mountainous north from the origin to Lake Serre Ponçon, a reservoir of 1.2 billion m³. Crop cultivation and large urban zones dominate below the lake. Flow rates and particle content vacillate with season - mostly due to snow melt - and with climatic events.

METHODS

Water samples from 21 sites along a 270 km stretch of the river were collected in winter, spring, summer and fall of 2016 and 2017.

Bacteria were isolated quantitatively via dilution plating on semi-selective media. Up to 30 randomly selected *P. syringae*-like colonies were isolated for each of the 168 samples and stored in buffer in 96-well plates before analysis.

Identification of the >6000 isolates was based on the partial sequence of the citrate synthase (*cts*) gene of each isolate obtained with a modified NGS approach. They were identified with the Dada2 bioinformatics pipeline in R and with phylogenetic analyses by comparing to a database of sequences for > 900 strains of *P. syringae* representing the full known genetic diversity of this complex.

RESULTS

POPULATION SIZES AND TRENDS

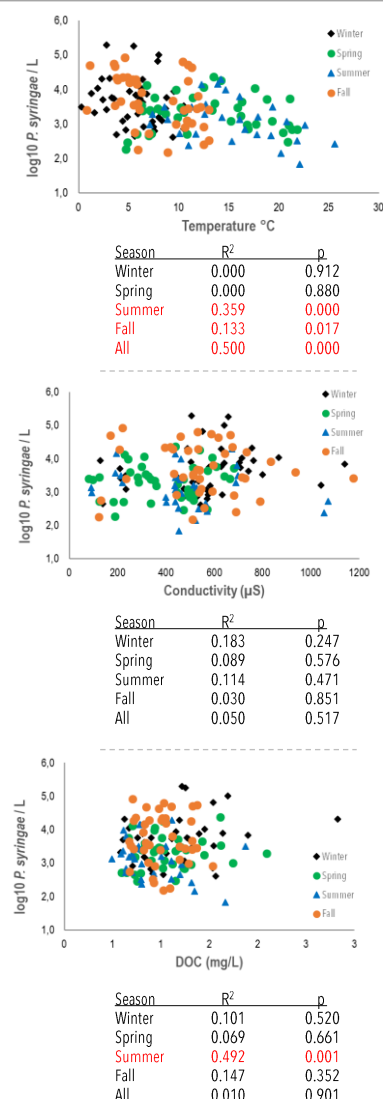
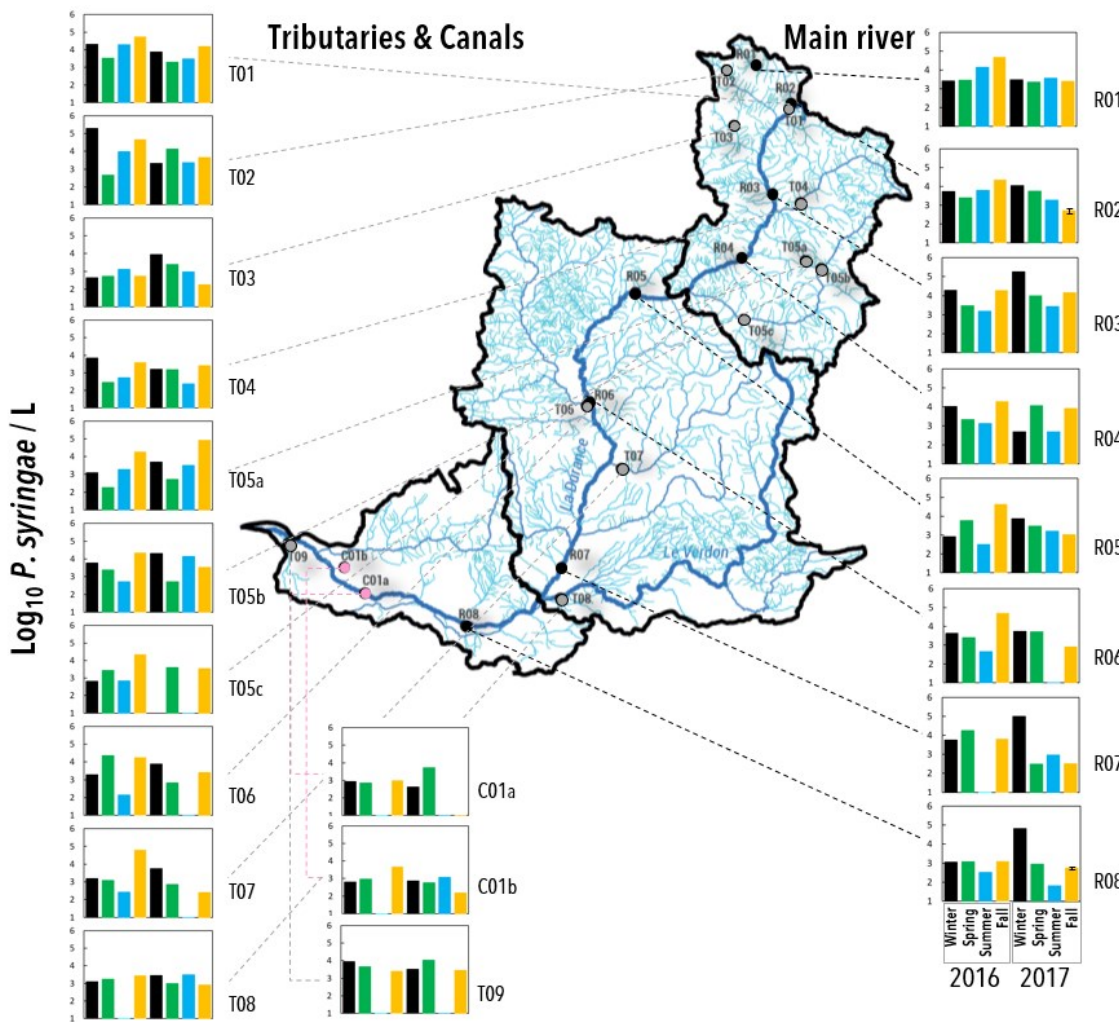


Figure 1. Concentrations of *P. syringae* in river and canal water in the Durance River basin.

Figure 2. Relationship of *P. syringae* concentrations & water traits.

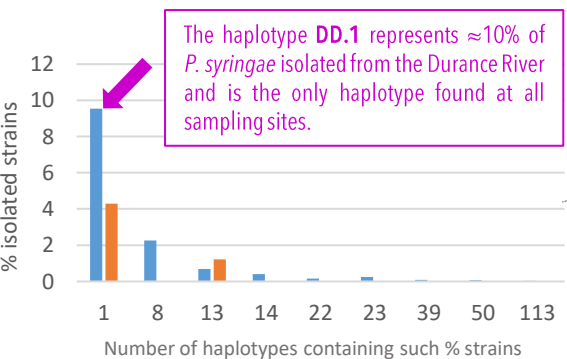


Figure 3. Distribution (%) of the 3195 bona fide *P. syringae* isolated from the Durance River in the 297 *cts* haplotypes

GENETIC DIVERSITY

Haplotype DD.1 corresponds to reference strains isolated from >10 countries (●), from the widest diversity of habitats,

- Plants
- Rain
- Groundwater
- Rivers
- Snow fall
- Snowpack
- Irrigation water
- Epilithic biofilms

& from epidemics on several hosts.



CONCLUSIONS

P. syringae is regularly present throughout the Durance River system with temperature as a major factor contributing to the variation in population sizes across seasons and different geographic contexts. The widespread occurrence of genetic lines with epidemic potential raises questions about their origins and how to survey river water and manage its use for irrigation.

[1] Morris et al. 2013. *Annu. Rev. Phytopath.*

[2] ANR project 17-CE32-0004 SPREE- Strategic preemptive pathogen surveillance of air and water to anticipate plant disease emergence in scenarios of changing land use

