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Pseudomonas fluorescens

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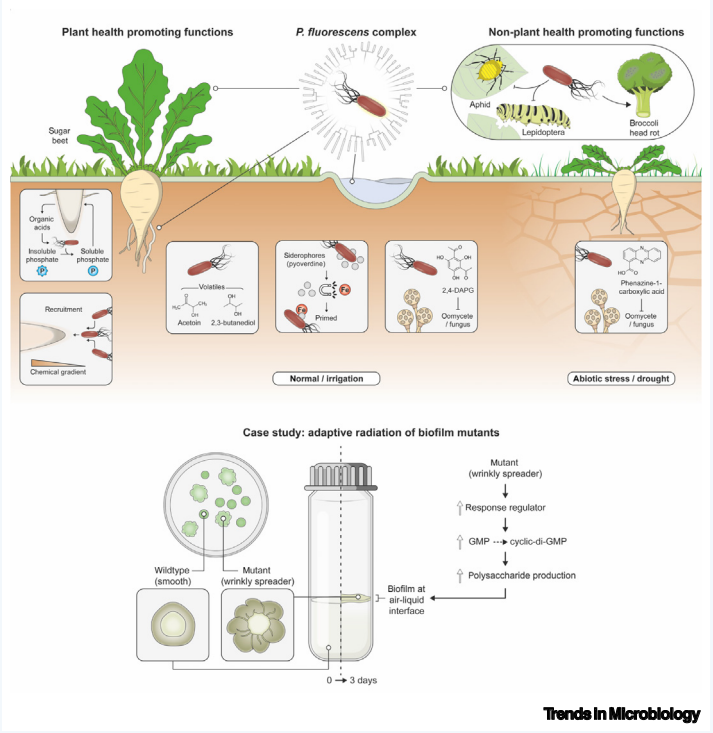

Pseudomonas fluorescens is a Gram-negative environmental bacterium often studied as a key contributor to plant and soil health. Pan-genome analysis suggests that *P. fluorescens* is not a single species, but is better described as a species complex (a set of closely related species that are very similar in appearance and traits), within which there are more than 50 species along with many unclassified isolates. This complex is highly diverse, both genetically and ecologically, with species inhabiting a variety of environments, including soil, water, plant tissues, and even dairy products. The species complex can be further divided into multiple phylogenomic groups, each exhibiting distinct traits, including plant growth promotion, biocontrol abilities, and the capacity to degrade pollutants. Novel species within the complex continue to be isolated from the rhizosphere, indicating that there is likely to be a large reservoir of bacteria belonging to the *P. fluorescens* species complex remaining uncharacterised.

KEY FACTS:

P. fluorescens gained its name because it fluoresces under UV light due to production of a green, iron-scavenging, siderophore called pyoverdine.

The bacterium is a member of a wider *P. fluorescens* species complex (including *Pseudomonas protegens, Pseudomonas chlororaphis,* and many others) that have a broad habitat range and are commonly found in soil, water, on plant surfaces, and in the rhizosphere.

P. fluorescens plays a role in soil and plant health via mechanisms such as nutrient cycling and the production of plant-growth-promoting substances, as well as producing antifungal and insect toxins, which make it attractive as a potential biocontrol agent.

Due to its diverse metabolic capabilities and its role in various ecological processes, *P. fluorescens* is often used as a model organism in studies related to microbiology, genetics, and environmental science.

DISEASE FACTS:

Historically, *P. fluorescens is* classified as a plant growth promoter; certain *P. fluorescens* strains can naturally colonise, and often kill, insects such as aphids and lepidoptera.

Some strains have been shown to cause disease in plants (e.g., broccoli head rot) and possibly contribute to human disease by association with other microbes or in immunocompromised individuals.

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P. fluorescens colonises many different plant habitats, including the rhizosphere, phyllosphere, and endosphere. It is classified as a plant-growth-promoting bacterium due to its ability to: (i) improve the availability of nutrients, such as phosphate, to plants; (ii) produce a range of antimicrobials (e.g., phenazines) that can antagonise oomycete and fungal plant pathogens; (iii) enhance stress resistance and biocontrol activity via the alteration of plant hormonal levels; and (iv) induce systemic resistance in plants through the production of extracellular molecules such as volatile organic compounds or siderophores, priming them to counteract potential infections. Plants can produce signals that select for different genotypes of *P. fluorescens* to colonise their roots. Different plant growth conditions, such as drought or irrigation, can lead to the recruitment of fluorescent Pseudomonads that produce different antimicrobials (e.g., phenazines or 2-DAPG), enabling them to effectively counteract fungal pathogens adapted to the specific growth conditions.

Bacterial populations have been instrumental in exploring adaptive processes *in vitro* through experimental evolution, owing to their minimal space requirements, rapid generation times, and their potential to be revived after freezing – allowing for the creation of 'frozen fossil records' documenting genetic and phenotypic changes over time. Due to its robust growth, genetic malleability, and diverse metabolic capabilities, *P. fluorescens* has been widely used as a model organism in experimental evolution studies for decades, offering key insights into evolutionary dynamics related to adaptive radiation, bacteria–phage coevolution, bacteria–plasmid coevolution, bacterial cooperation, fitness trade-offs, gene regulatory network evolution, and more recently, predator–prey dynamics. One of the most well-known studies examined the adaptive radiation of *P. fluorescens* in static microcosms, which provided important insights into how bacteria diversify and adapt through natural selection, even in simple semi-structured environments.

Pioneering work from Andrew Spiers and Paul Rainey uncovered the molecular and genetic mechanisms driving bacterial diversification, demonstrating how simple mutations can lead to niche differentiation and evolutionary success. In short, mutations in the *wsp* regulatory pathway result in constitutive expression of the response regulator WspR, raising cyclic-di-GMP levels and promoting extracellular polysaccharide production. The resulting phenotype is a mutant with robust biofilm formation and wrinkled colonies; this gives the bacteria a competitive advantage at the air–liquid interface. Environmental strains that form cellulose-based biofilms in static microcosms have been isolated from natural habitats, suggesting that these mutations also provide a fitness advantage outside of laboratory settings.

TAXONOMY AND CLASSIFICATION:
KINGDOM: Bacteria
PHYLUM: Pseudomonadota
CLASS: Gammaproteobacteria
ORDER: Pseudomonadales
FAMILY: Pseudomonadaceae
GENUS: *Pseudomonas*
SPECIES GROUP: *Pseudomonas fluorescens* group
SPECIES: *Pseudomonas fluorescens*

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Declaration of interests

The authors declare no competing interests.

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