

# Whole-Genome Sequencing of 10 *Pseudomonas syringae* Strains Representing Different Host Range Spectra

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***Pseudomonas syringae* is a ubiquitous bacterium that readily persists in environmental habitats as a saprophyte and also is responsible for numerous diseases of crops. Here, we report the whole-genome sequences of 10 strains isolated from both woody and herbaceous plants that will contribute to the elucidation of the determinants of their host ranges.**

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The *Pseudomonas syringae* complex is composed of 13 phylogenetic groups (1) collectively able to cause disease on more than one hundred plant species (2, 3). *P. syringae* strains have also been isolated from substrates other than plants in various habitats linked to the water cycle. Many of these environmental strains, when tested in the laboratory, are also pathogenic for several plant species (4, 5). Here, we sequenced, assembled, and annotated the whole genomes of 10 strains of *P. syringae* isolated from diverse plants and representing 3 phylogenetic groups. These strains were chosen to represent different host range spectra based on the results of research to be reported elsewhere. From phylogroup 1, the strains included CFBP 1657 (pv. *maculicola*) isolated from *Brassica oleracea*, CFBP 1702 (pv. *viburni*) isolated from *Viburnum* sp., and PaVt10 (5) (pv. *avellanae*) isolated from *Corylus avellana*. From phylogroup 2, the strains were 41a from *Prunus armeniaca* and CFBP 1754 (pv. *papulans*) from *Malus sylvestris*. From phylogroup 3, we sequenced the genomes of strains CFBP 3205 (pv. *amygdali*) from *Prunus dulcis*, CFBP 3225 (pv. *meliae*) from *Melia azedarach*, CFBP 3226 (pv. *dendropanacis*) from *Dendropanax trifidus*, CFBP 4219 (pv. *daphniphylli*) from *Daphniphyllum* sp.,

and PseNe107 (5) (pv. *savastanoi*) from *Olea europaea*. With the exception of strain 41a, all other strains were from reference collections and were described previously. For all strains, DNA was extracted by using the Qiagen Genomic-tip 100/G kit after growing strains overnight at 26°C in a liquid nutrient broth. Illumina libraries were constructed with the NEXTflex PCR-free DNA sequencing kit and NEXTflex PCR-free barcodes, and genomes were sequenced by using MiSeq M00185 (250-bp paired-end reads). The insert sizes for each genome are reported in Table 1. Overall, the average insert size was 389 bp. *De novo* assembly was performed by using a pipeline that consists of a combination of Velvet (6), SOAPdenovo, and SOAPdenovo2 (7). The structural annotation of the contigs was achieved as previously described (8). The features for each genome are reported in Table 1. Analysis of the 10 *P. syringae* genomes showed that all strains present a complete type III secretion system.

**Nucleotide sequence accession numbers.** These whole-genome shotgun projects have been deposited at DDBJ/EMBL/GenBank under the accession numbers listed in Table 1.

TABLE 1 Genome characteristics

Strain name	Phylogroup	Accession no.	Genome size (bp)	Insert size (bp)	No. of contigs	$N_{50}$ (bp)	No. of protein-coding genes	G+C content (%)
CFBP 1657	1	<a href="https://doi.org/10.1128/genomeA.00379-15">JYHH00000000</a>	891,415,000	374	138	122,411	5,209	58.43
CFBP 1702	1	<a href="https://doi.org/10.1128/genomeA.00379-15">JYHK00000000</a>	944,775,000	397	265	98,077	5,595	58.60
PaVt10	1	<a href="https://doi.org/10.1128/genomeA.00379-15">JYHC00000000</a>	899,519,500	392	455	30,706	4,807	58.82
41a	2	<a href="https://doi.org/10.1128/genomeA.00379-15">JYHJ00000000</a>	930,312,000	372	24	665,729	5,126	59.11
CFBP 1754	2	<a href="https://doi.org/10.1128/genomeA.00379-15">JYHI00000000</a>	735,876,000	394	182	132,813	2,378	58.97
CFBP 3205	3	<a href="https://doi.org/10.1128/genomeA.00379-15">JYHB00000000</a>	697,222,500	404	343	35,334	4,934	58.29
CFBP 3225	3	<a href="https://doi.org/10.1128/genomeA.00379-15">JYHE00000000</a>	733,793,000	390	360	34,681	4,344	58.40
CFBP 3226	3	<a href="https://doi.org/10.1128/genomeA.00379-15">JYHG00000000</a>	545,040,500	370	247	73,921	4,988	58.11
CFBP 4219	3	<a href="https://doi.org/10.1128/genomeA.00379-15">JYHD00000000</a>	614,308,500	403	377	47,492	5,100	58.12
PseNe107	3	<a href="https://doi.org/10.1128/genomeA.00379-15">JYHF00000000</a>	853,186,500	396	247	109,046	5,303	58.02

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## REFERENCES

1. Berge O, Monteil CL, Bartoli C, Chandeysson C, Guilbaud C, Sands DC, Morris CE. 2014. A user's guide to a data base of the diversity of *Pseudomonas syringae* and its application to classifying strains in this phylogenetic complex. PLoS One 9:e105547. <http://dx.doi.org/10.1371/journal.pone.0105547>.
2. Lamichhane JR, Varvaro L, Parisi L, Audergon J-M, Morris CE. 2014. Disease and frost damage of woody plants caused by *Pseudomonas syringae*: seeing the forest for the trees. Adv Agron 126:235–295. <http://dx.doi.org/10.1016/B978-0-12-800132-5.00004-3>.
3. Lamichhane JR, Messéan A, Morris CE. 2015. Insights into epidemiology and control of diseases of annual plants caused by the *Pseudomonas syringae* species complex. J Gen Plant Pathol, in press.
4. Morris CE, Kinkel LL, Xiao K, Prior P, Sands DC. 2007. Surprising niche for the plant pathogen *Pseudomonas syringae*. Infect Genet Evol 7:84–92. <http://dx.doi.org/10.1016/j.meegid.2006.05.002>.
5. Bartoli C, Lamichhane JR, Berge O, Guilbaud C, Varvaro L, Balestra GM, Vinatzer BA, Morris CE. 2015. A framework to gauge the epidemic potential of plant pathogens in environmental reservoirs: the example of kiwifruit canker. Mol Plant Pathol 16:137–149. <http://dx.doi.org/10.1111/mpp.12167>.
6. Zerbino DR, Birney E. 2008. Velvet: algorithms for *de novo* short read assembly using de Bruijn graphs. Genome Res 18:821–829. <http://dx.doi.org/10.1101/gr.074492.107>.
7. Luo R, Liu B, Xie Y, Li Z, Huang W, Yuan J, He G, Chen Y, Pan Q, Liu Y, Tang J, Wu G, Zhang H, Shi Y, Liu Y, Yu C, Wang B, Lu Y, Han C, Cheung DW, Yiu S-M, Peng S, Xiaoqian Z, Liu G, Liao X, Li Y, Yang H, Wang J, Lam T-W, Wang J. 2012. SOAPdenovo2: an empirically improved memory-efficient short-read *de novo* assembler. Gigascience 1:18. <http://dx.doi.org/10.1186/2047-217X-1-18>.
8. Sallet E, Gouzy J, Schiex T. 2014. EuGene-PP: a next-generation automated annotation pipeline for prokaryotic genomes. Bioinformatics 30:2659–2661. <http://dx.doi.org/10.1093/bioinformatics/btu366>.