

***Sphingomonas lacusdianchii* sp. nov., an attached bacterium  
inhibited by metabolites from its symbiotic cyanobacterium**

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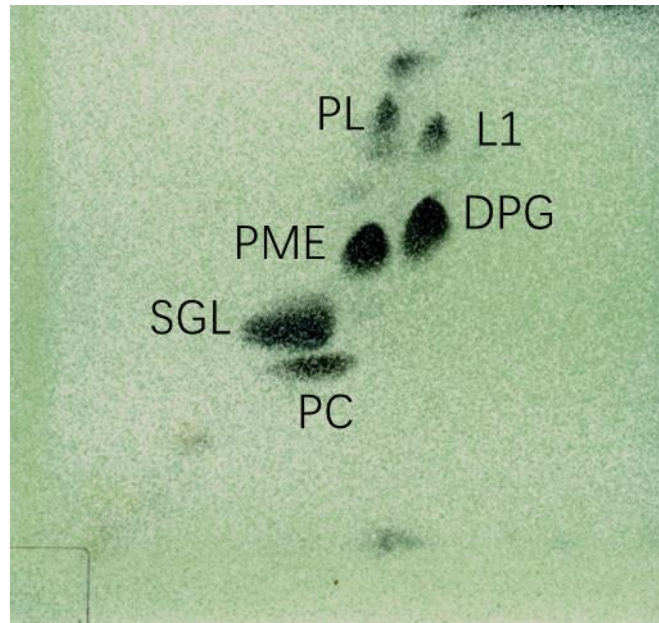
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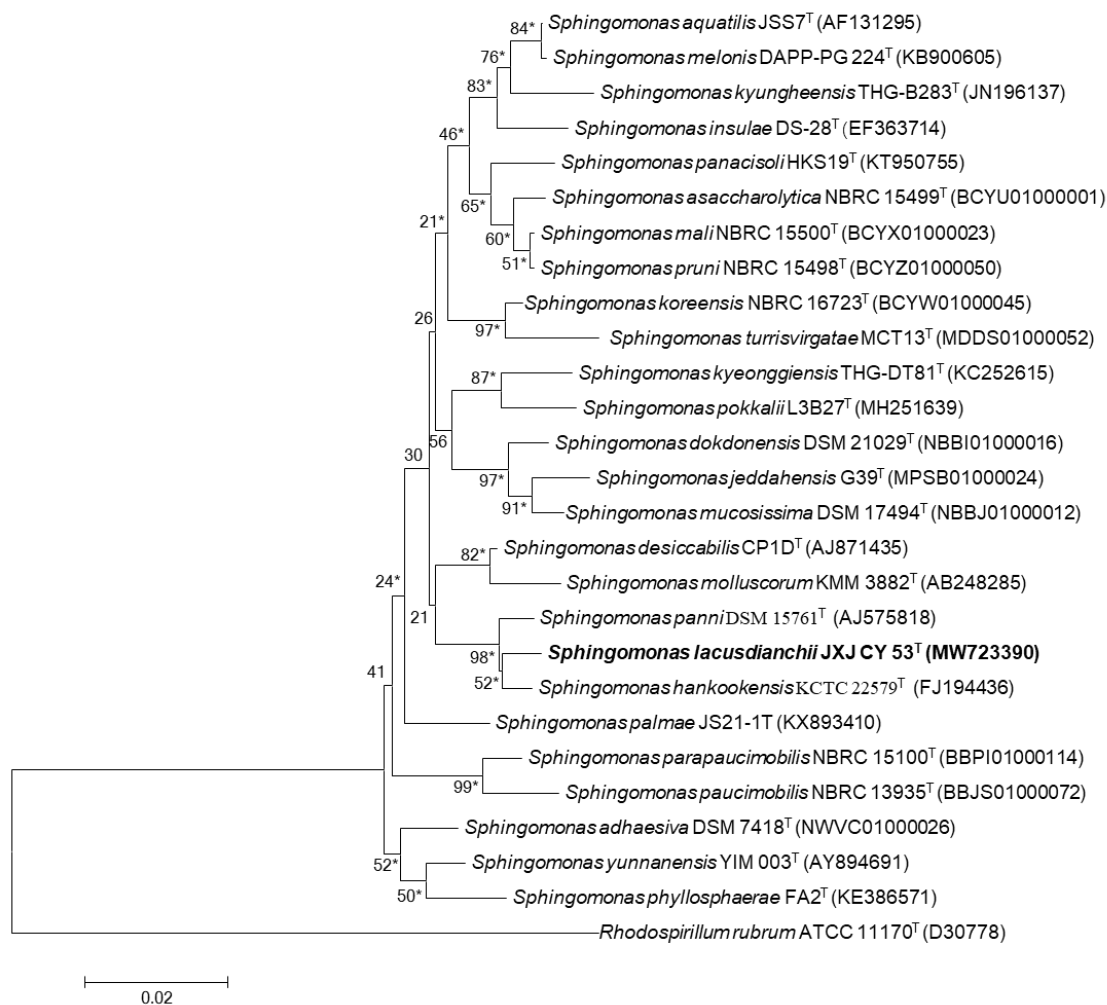
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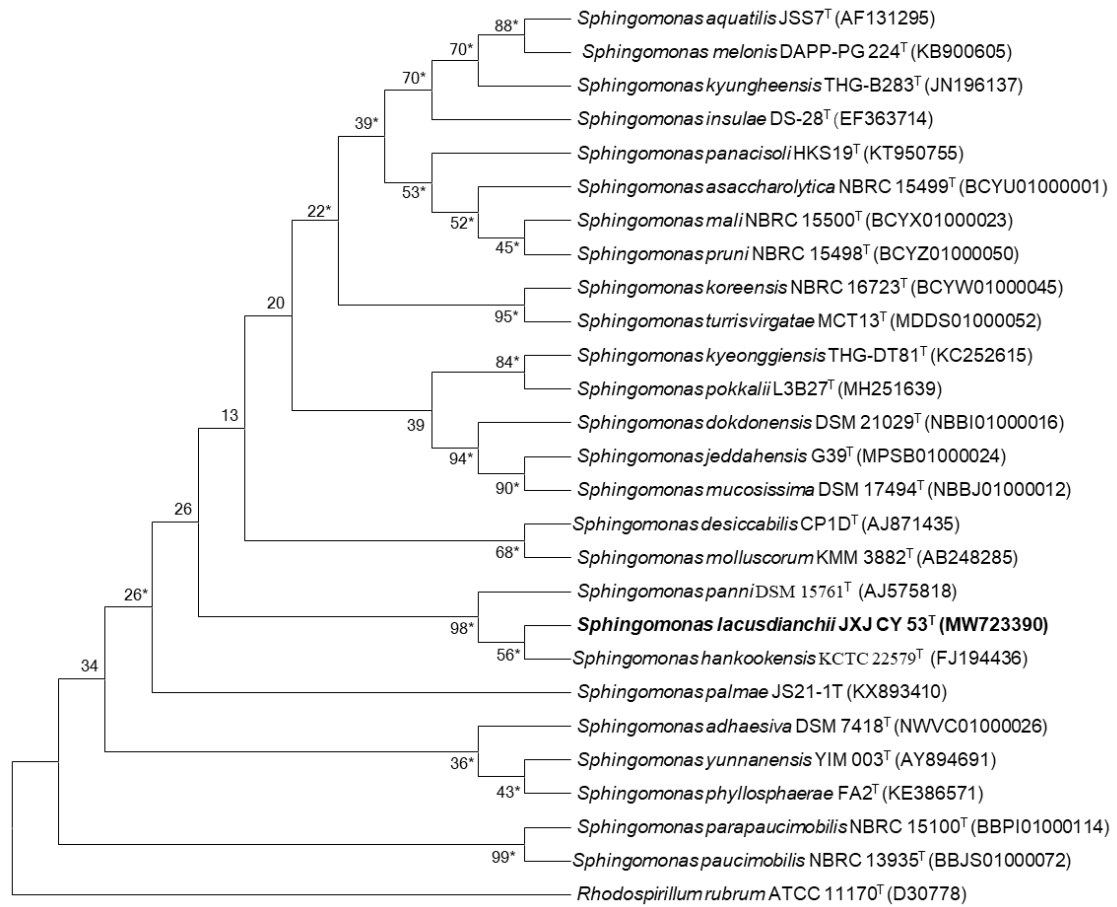


**Fig. S1** The polar lipids of strain JXJ CY 53<sup>T</sup> as revealed by two-dimensional TLC.

DPG, diphosphatidylglycerol; PME, phosphatidylmethylethanolamine; SGL, sphingoglycolipid; PC, phosphatidylcholine; PL, an unidentified phospholipid; L1, unidentified lipid.

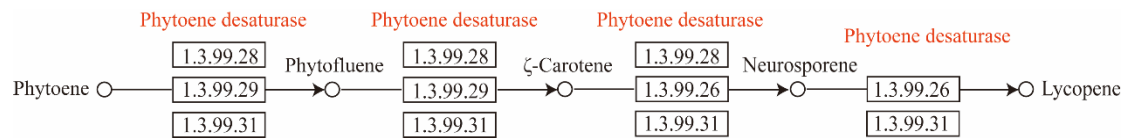


**Fig. S2** Maximum-likelihood phylogenetic tree based on 16S rRNA gene sequences of strain JXJ CY 53<sup>T</sup> and its closest relative species of the genus *Sphingomonas*. \* indicated clades that were conserved in neighbour-joining, maximum-likelihood and maximum-parsimony trees. Bar, 0.02 changes per nucleotide position.

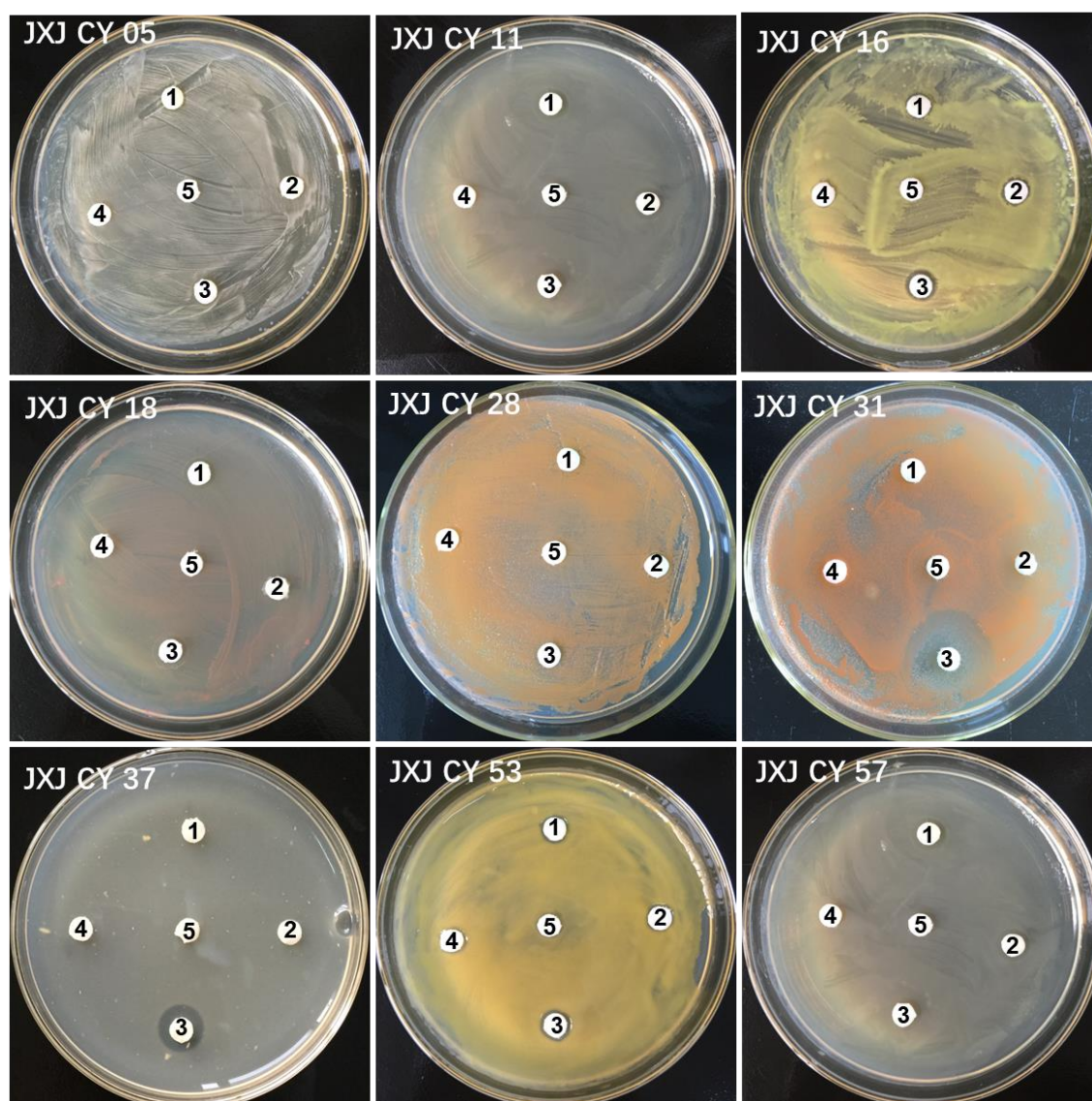


**Fig. S3** Maximum-parsimony phylogenetic tree based on 16S rRNA gene sequences of strain JXJ CY 53<sup>T</sup> and its closest relative species of the genus *Sphingomonas*. \* indicated clades that were conserved in neighbour-joining, maximum-likelihood and maximum-parsimony trees.

**Fig. S4** The KEGG pathway for phosphate assimilation and nitrogen fixation of the strains JXJ CY 53<sup>T</sup>, *S. panni* DSM 15761<sup>T</sup> and *S. hankookensis* KCTC 22579<sup>T</sup>.



**Fig. S5** Putative overview of four-step desaturations which desaturated phytoene to lycopene of the strains JXJ CY 53<sup>T</sup>, *S. panni* DSM 15761<sup>T</sup> and *S. hankookensis* KCTC 22579<sup>T</sup>.



**Fig. S6** Inhibitory activity of extracts from MF-905 on nine attached bacterial strains. 1, 2, 3, 4, and 5 indicated the total extract from Mf-905, in addition to fractions I, II, III, and IV, respectively. Only fraction III contained MC-LR.

**Table S1** Cellular fatty acid profile of strain JXJ CY 53<sup>T</sup> and related reference strains

| Fatty acid                                   | JXJ CY<br>53 <sup>T</sup> | <i>S. panni</i> DSM 15761 <sup>T</sup><br>(Busse et al. 2005) | <i>S. hankookensis</i> KCTC 22579 <sup>T</sup><br>(Yoon et al. 2009) |
|----------------------------------------------|---------------------------|---------------------------------------------------------------|----------------------------------------------------------------------|
| C <sub>14:0</sub>                            | 0.99                      | 1.1                                                           | 1.1                                                                  |
| C <sub>15:0</sub>                            | -                         | 1.1                                                           | 0.5                                                                  |
| C <sub>16:0</sub>                            | 14.56                     | 17.8                                                          | 11.5                                                                 |
| C <sub>17:0</sub>                            | 0.59                      | ND                                                            | ND                                                                   |
| C <sub>18:0</sub>                            | 0.32                      | ND                                                            | ND                                                                   |
| C <sub>16:1</sub> ω7c/16:1ω6c                | 10.78                     | ND                                                            | ND                                                                   |
| C <sub>16:1</sub> ω7c/ iso C <sub>15:0</sub> | -                         | 17.1                                                          | 16.2                                                                 |
| 2-OH                                         |                           |                                                               |                                                                      |
| C <sub>16:1</sub> ω5c                        | 4.74                      | 2.1                                                           | 5.4                                                                  |
| C <sub>17:1</sub> ω8c                        | 0.94                      | ND                                                            | 0.5                                                                  |
| C <sub>17:1</sub> ω6c                        | 7.60                      | 3.6                                                           | 3.7                                                                  |
| C <sub>18:1</sub> ω7c                        | 48.74                     | 51.3                                                          | 53.9                                                                 |
| C <sub>18:1</sub> ω5c                        | 1.75                      | 0.7                                                           | 1.2                                                                  |
| C <sub>14:0</sub> 2-OH                       | 2.58                      | 5.3                                                           | 5.6                                                                  |
| C <sub>15:0</sub> 2-OH                       | 0.41                      | ND                                                            | 0.2                                                                  |
| 11-Methyl C <sub>18:1</sub> ω7c              | 4.62                      | ND                                                            | ND                                                                   |

-, No related fatty acids detected; ND, No data.

**Table S2** The possibly partial important genes or gene clusters for strain JXJ CY 53<sup>T</sup> to adapt to the ecology of MF-905

| Level | GO         | Term                                                                                         | Ontology           | Gene_num | Gene_list                                                                                                                                  |
|-------|------------|----------------------------------------------------------------------------------------------|--------------------|----------|--------------------------------------------------------------------------------------------------------------------------------------------|
| 3     | GO:0052192 | Movement in environment of other organism involved in symbiotic interaction                  | Biological_process | 10       | PROKKA_01138, PROKKA_00237, PROKKA_00152, PROKKA_04210, PROKKA_00903, PROKKA_02877, PROKKA_02157, PROKKA_04445, PROKKA_00007, PROKKA_02486 |
| 4     | GO:0051828 | Entry into other organism involved in symbiotic interaction                                  | Biological_process | 9        | PROKKA_01138, PROKKA_00237, PROKKA_00152, PROKKA_04210, PROKKA_00903, PROKKA_02877, PROKKA_02157, PROKKA_04445, PROKKA_00007               |
| 4     | GO:0052173 | Response to defenses of other organism involved in symbiotic interaction                     | Biological_process | 4        | PROKKA_02934, PROKKA_02032, PROKKA_01408, PROKKA_02419                                                                                     |
| 4     | GO:0052195 | Movement on or near other organism involved in symbiotic interaction                         | Biological_process | 1        | PROKKA_02486                                                                                                                               |
| 4     | GO:0052216 | Chemotaxis in environment of other organism involved in symbiotic interaction                | Biological_process | 1        | PROKKA_02486                                                                                                                               |
| 5     | GO:0051806 | Entry into cell of other organism involved in symbiotic interaction                          | Biological_process | 9        | PROKKA_01138, PROKKA_00237, PROKKA_00152, PROKKA_04210, PROKKA_00903, PROKKA_02877, PROKKA_02157, PROKKA_04445, PROKKA_00007               |
| 5     | GO:0051807 | Evasion or tolerance of defense response of other organism involved in symbiotic interaction | Biological_process | 1        | PROKKA_02934                                                                                                                               |

|   |            |                                                                                                                    |                    |   |                                                        |
|---|------------|--------------------------------------------------------------------------------------------------------------------|--------------------|---|--------------------------------------------------------|
| 5 | GO:0051832 | Avoidance of defenses of other organism involved in symbiotic interaction                                          | Biological_process | 1 | PROKKA_02934                                           |
| 5 | GO:0052243 | Chemotaxis on or near other organism involved in symbiotic interaction                                             | Biological_process | 1 | PROKKA_02486                                           |
| 5 | GO:0052564 | Response to immune response of other organism involved in symbiotic interaction                                    | Biological_process | 4 | PROKKA_02934, PROKKA_02032, PROKKA_01408, PROKKA_02419 |
| 6 | GO:0051805 | Evasion or tolerance of immune response of other organism involved in symbiotic interaction                        | Biological_process | 1 | PROKKA_02934                                           |
| 6 | GO:0051834 | Evasion or tolerance of defenses of other organism involved in symbiotic interaction                               | Biological_process | 1 | PROKKA_02934                                           |
| 6 | GO:0052143 | Chemotaxis on or near host involved in symbiotic interaction                                                       | Biological_process | 1 | PROKKA_02486                                           |
| 6 | GO:0052550 | Response to defense-related reactive oxygen species production by other organism involved in symbiotic interaction | Biological_process | 1 | PROKKA_02934                                           |

|   |            |                                                                                                                          |                    |   |                                                        |
|---|------------|--------------------------------------------------------------------------------------------------------------------------|--------------------|---|--------------------------------------------------------|
| 6 | GO:0052551 | Response to defense-related nitric oxide production by other organism involved in symbiotic interaction                  | Biological_process | 1 | PROKKA_02934                                           |
| 6 | GO:0052572 | Response to host immune response                                                                                         | Biological_process | 4 | PROKKA_02934, PROKKA_02032, PROKKA_01408, PROKKA_02419 |
| 7 | GO:0020012 | Evasion or tolerance of host immune response                                                                             | Biological_process | 1 | PROKKA_02934                                           |
| 7 | GO:0052376 | Evasion or tolerance by organism of nitric oxide produced by other organism involved in symbiotic interaction            | Biological_process | 1 | PROKKA_02934                                           |
| 7 | GO:0052385 | Evasion or tolerance by organism of reactive oxygen species produced by other organism involved in symbiotic interaction | Biological_process | 1 | PROKKA_02934                                           |

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**Table S3** The possibly partial important genes and gene clusters related to the signal transductions and nutrient exchanges between strain JXJ CY 53<sup>T</sup> and MF-905

| Level | GO        | Term                               | Ontology           | Gene_num | Gene_list                                                                                                                                                                                                                                                                                                                        |
|-------|-----------|------------------------------------|--------------------|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|       |           | ATP-binding                        |                    |          |                                                                                                                                                                                                                                                                                                                                  |
| 3     | GO:043190 | cassette (ABC) transporter complex | Cellular_component | 4        | PROKKA_02408, PROKKA_01215, PROKKA_03018, PROKKA_00590                                                                                                                                                                                                                                                                           |
|       |           | Type II                            |                    |          |                                                                                                                                                                                                                                                                                                                                  |
| 3     | GO:015627 | protein secretion system complex   | Cellular_component | 8        | PROKKA_00602, PROKKA_00584, PROKKA_00577, PROKKA_00583, PROKKA_00576, PROKKA_00580, PROKKA_00581, PROKKA_00582                                                                                                                                                                                                                   |
|       |           | Type I protein                     |                    |          |                                                                                                                                                                                                                                                                                                                                  |
| 3     | GO:030256 | secretion system complex           | Cellular_component | 1        | PROKKA_03647                                                                                                                                                                                                                                                                                                                     |
|       |           | Type III                           |                    |          |                                                                                                                                                                                                                                                                                                                                  |
| 3     | GO:030257 | protein secretion system complex   | Cellular_component | 1        | PROKKA_00980                                                                                                                                                                                                                                                                                                                     |
|       |           |                                    |                    |          | PROKKA_03648, PROKKA_00583, PROKKA_00459, PROKKA_00576, PROKKA_01857, PROKKA_00580, PROKKA_00980, PROKKA_03594, PROKKA_03294, PROKKA_00602, PROKKA_00584, PROKKA_00577, PROKKA_03855, PROKKA_04123, PROKKA_00458, PROKKA_00581, PROKKA_00601, PROKKA_01436, PROKKA_00987, PROKKA_00988, PROKKA_00990, PROKKA_03647, PROKKA_00582 |
| 5     | GO:009306 | Protein secretion                  | Biological_process | 23       |                                                                                                                                                                                                                                                                                                                                  |

|   |           |                                                    |                    |    |                                                                                                                                                                                      |
|---|-----------|----------------------------------------------------|--------------------|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 6 | GO:015628 | Protein secretion by the type II secretion system  | Biological_process | 8  | PROKKA_00602, PROKKA_00584, PROKKA_00577, PROKKA_00583, PROKKA_00576, PROKKA_00580, PROKKA_00581, PROKKA_00582                                                                       |
| 6 | GO:030253 | Protein secretion by the type I secretion system   | Biological_process | 1  | PROKKA_03647                                                                                                                                                                         |
| 6 | GO:030254 | Protein secretion by the type III secretion system | Biological_process | 1  | PROKKA_00980                                                                                                                                                                         |
| 6 | GO:009734 | Auxin mediated signaling pathway                   | Biological_process | 1  | PROKKA_01128                                                                                                                                                                         |
| 6 | GO:009785 | Blue light signaling pathway                       | Biological_process | 5  | PROKKA_00834, PROKKA_00664, PROKKA_01061, PROKKA_03349, PROKKA_03413                                                                                                                 |
| 6 | GO:015926 | Glucosidase activity                               | Molecular_function | 13 | PROKKA_00385, PROKKA_01314, PROKKA_04116, PROKKA_01589, PROKKA_00283, PROKKA_00208, PROKKA_01606, PROKKA_01981, PROKKA_03467, PROKKA_00271, PROKKA_02311, PROKKA_00676, PROKKA_01879 |

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|---|------------|------------------------------------|--------------------|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7 | GO:004558  | Alpha-glucosidase activity         | Molecular_function | 6  | PROKKA_02311, PROKKA_00385, PROKKA_01314, PROKKA_01589, PROKKA_01981, PROKKA_00271                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 7 | GO:004575  | Sucrose alpha-glucosidase activity | Molecular_function | 2  | PROKKA_02311, PROKKA_01314                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 7 | GO:008422  | Beta-glucosidase activity          | Molecular_function | 7  | PROKKA_00676, PROKKA_04116, PROKKA_00283, PROKKA_01879, PROKKA_00208, PROKKA_01606, PROKKA_03467                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 8 | GO:0032450 | Maltose alpha-glucosidase activity | Molecular_function | 4  | PROKKA_01589, PROKKA_00385, PROKKA_01981, PROKKA_00271                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 5 | GO:0016052 | Carbohydrate catabolic process     | Biological_process | 85 | PROKKA_01583, PROKKA_01882, PROKKA_00888, PROKKA_02864, PROKKA_02647, PROKKA_03289, PROKKA_00249, PROKKA_01194, PROKKA_00367, PROKKA_04087, PROKKA_04151, PROKKA_03150, PROKKA_00319, PROKKA_00260, PROKKA_03628, PROKKA_00448, PROKKA_00676, PROKKA_04012, PROKKA_00311, PROKKA_00241, PROKKA_01535, PROKKA_03287, PROKKA_02599, PROKKA_00552, PROKKA_01737, PROKKA_01996, PROKKA_01606, PROKKA_01659, PROKKA_03503, PROKKA_04086, PROKKA_03381, PROKKA_04001, PROKKA_00268, PROKKA_01002, PROKKA_03133, PROKKA_01161, PROKKA_04256, PROKKA_02751, PROKKA_03203, PROKKA_02859, PROKKA_03610, PROKKA_03131, PROKKA_03801, PROKKA_01067, PROKKA_02579, PROKKA_02609, PROKKA_02436, PROKKA_02537, PROKKA_00629, PROKKA_03467, PROKKA_03663, PROKKA_02531, PROKKA_00617, PROKKA_00369, PROKKA_03117, PROKKA_00828, PROKKA_04257, PROKKA_00656, PROKKA_03672, PROKKA_01988, |

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|---|-----------|------------------------------------------------|--------------------|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5 | GO:044275 | Cellular carbohydrate catabolic process        | Biological_process | 28 | PROKKA_00657, PROKKA_03263, PROKKA_01580, PROKKA_00923, PROKKA_03290, PROKKA_01314, PROKKA_00312, PROKKA_01584, PROKKA_01973, PROKKA_03796, PROKKA_00364, PROKKA_01150, PROKKA_01761, PROKKA_01558, PROKKA_02583, PROKKA_03379, PROKKA_00280, PROKKA_00370, PROKKA_00086, PROKKA_02591, PROKKA_03051, PROKKA_01070, PROKKA_00896, PROKKA_04007, PROKKA_04113, PROKKA_03801, PROKKA_01583, PROKKA_01314, PROKKA_02537, PROKKA_00552, PROKKA_01606, PROKKA_01194, PROKKA_03467, PROKKA_01973, PROKKA_04087, PROKKA_03663, PROKKA_02531, PROKKA_01150, PROKKA_03150, PROKKA_00617, PROKKA_04086, PROKKA_00676, PROKKA_01558, PROKKA_00268, PROKKA_03117, PROKKA_00828, PROKKA_00656, PROKKA_04012, PROKKA_03672, PROKKA_01161, PROKKA_00657, PROKKA_03263, PROKKA_00896, PROKKA_01583, PROKKA_02864, PROKKA_03289, PROKKA_01194, PROKKA_00367, PROKKA_04087, PROKKA_04151, PROKKA_03150, PROKKA_00319, PROKKA_03628, PROKKA_00676, PROKKA_04012, PROKKA_00311, PROKKA_03287, PROKKA_02599, PROKKA_00552, PROKKA_01737, PROKKA_01606, PROKKA_01659, PROKKA_04086, PROKKA_00268, PROKKA_01002, PROKKA_01161, PROKKA_04256, PROKKA_02751, PROKKA_03203, PROKKA_01067, PROKKA_03801, PROKKA_02579, PROKKA_02609, PROKKA_02436, PROKKA_02537, PROKKA_00629, PROKKA_03467, PROKKA_02531, PROKKA_03663, PROKKA_00617, PROKKA_00369, PROKKA_03117, PROKKA_04257, PROKKA_00828, PROKKA_00656, PROKKA_03672, PROKKA_00657, PROKKA_03263, PROKKA_00923, PROKKA_03290, PROKKA_01314, PROKKA_00312, PROKKA_01584, PROKKA_03796, PROKKA_01973, PROKKA_00364, PROKKA_01150, PROKKA_01761, PROKKA_01558, PROKKA_02583, PROKKA_00280, PROKKA_00370, PROKKA_01070, PROKKA_00896 |
| 6 | GO:044724 | Single-organism carbohydrate catabolic process | Biological_process | 61 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

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|---|------------|-------------------------------------------|--------------------|----|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 6 | GO:0080030 | Methyl indole-3-acetate esterase activity | Molecular_function | 2  | PROKKA_03557, PROKKA_03772                                                                                                                               |
| 8 | GO:006596  | Polyamine biosynthetic process            | Biological_process | 5  | PROKKA_00082, PROKKA_00034, PROKKA_03587, PROKKA_04150, PROKKA_04148                                                                                     |
| 7 | GO:000162  | Tryptophan biosynthetic process           | Biological_process | 4  | PROKKA_01947, PROKKA_03386, PROKKA_03385, PROKKA_02438                                                                                                   |
| 4 | GO:0045436 | Lycopene beta cyclase activity            | Molecular_function | 1  | PROKKA_03866                                                                                                                                             |
| 5 | GO:0016117 | Carotenoid biosynthetic process           | Biological_process | 4  | PROKKA_03867, PROKKA_03866, PROKKA_04377, PROKKA_03869                                                                                                   |
| 3 | GO:0051183 | Vitamin transporter activity              | Molecular_function | 11 | PROKKA_02637, PROKKA_03155, PROKKA_00639, PROKKA_00543, PROKKA_01010, PROKKA_01227, PROKKA_01603, PROKKA_03103, PROKKA_03014, PROKKA_01612, PROKKA_03844 |
| 3 | GO:0009349 | Riboflavin synthase complex               | Cellular_component | 1  | PROKKA_04389                                                                                                                                             |
| 4 | GO:0004076 | Biotin synthase activity                  | Molecular_function | 1  | PROKKA_00387                                                                                                                                             |

|   |            |                                            |                    |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|---|------------|--------------------------------------------|--------------------|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4 | GO:0051180 | Vitamin transport                          | Biological_process | 1  | PROKKA_00635                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 4 | GO:0015235 | Cobalamin transporter activity             | Molecular_function | 11 | PROKKA_02637, PROKKA_03155, PROKKA_00639, PROKKA_00543, PROKKA_01010, PROKKA_01227, PROKKA_01603, PROKKA_03103, PROKKA_03014, PROKKA_01612, PROKKA_03844                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 5 | GO:0004746 | Riboflavin synthase activity               | Molecular_function | 1  | PROKKA_04387                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 5 | GO:0009110 | Vitamin biosynthetic process               | Biological_process | 43 | PROKKA_00379, PROKKA_00631, PROKKA_00995, PROKKA_00638, PROKKA_02743, PROKKA_03124, PROKKA_03387, PROKKA_02524, PROKKA_04338, PROKKA_00380, PROKKA_03917, PROKKA_04237, PROKKA_03752, PROKKA_00387, PROKKA_04386, PROKKA_00632, PROKKA_00633, PROKKA_01101, PROKKA_01741, PROKKA_03722, PROKKA_00277, PROKKA_02746, PROKKA_00363, PROKKA_02467, PROKKA_02720, PROKKA_02406, PROKKA_00630, PROKKA_03872, PROKKA_00111, PROKKA_00637, PROKKA_04388, PROKKA_03934, PROKKA_04387, PROKKA_00381, PROKKA_02967, PROKKA_00293, PROKKA_04325, PROKKA_04360, PROKKA_02024, PROKKA_00641, PROKKA_03738, PROKKA_04079, PROKKA_04389 |
| 5 | GO:0015889 | Cobalamin transport                        | Biological_process | 1  | PROKKA_00635                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 6 | GO:0042364 | Water-soluble vitamin biosynthetic process | Biological_process | 43 | PROKKA_00379, PROKKA_00631, PROKKA_00995, PROKKA_00638, PROKKA_02743, PROKKA_03124, PROKKA_03387, PROKKA_02524, PROKKA_04338, PROKKA_00380, PROKKA_03917, PROKKA_04237, PROKKA_03752, PROKKA_00387, PROKKA_04386, PROKKA_00632, PROKKA_00633, PROKKA_01101, PROKKA_01741, PROKKA_03722, PROKKA_00277, PROKKA_02746, PROKKA_00363, PROKKA_02467, PROKKA_02720,                                                                                                                                                                                                                                                            |

|   |             |                                  |                    |    |                                                                                                                                                                                                                                                            |
|---|-------------|----------------------------------|--------------------|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|   |             |                                  |                    |    | PROKKA_02406, PROKKA_00630, PROKKA_03872, PROKKA_00111, PROKKA_00637, PROKKA_04388, PROKKA_03934, PROKKA_04387, PROKKA_00381, PROKKA_02967, PROKKA_00293, PROKKA_04325, PROKKA_04360, PROKKA_02024, PROKKA_00641, PROKKA_03738, PROKKA_04079, PROKKA_04389 |
| 6 | GO:0009102  | Biotin biosynthetic process      | Biological_process | 5  | PROKKA_00379, PROKKA_02406, PROKKA_00381, PROKKA_00387, PROKKA_00380                                                                                                                                                                                       |
| 7 | GO:0009236  | Cobalamin biosynthetic process   | Biological_process | 13 | PROKKA_00631, PROKKA_00995, PROKKA_00638, PROKKA_00630, PROKKA_03124, PROKKA_02524, PROKKA_00637, PROKKA_02967, PROKKA_00632, PROKKA_00633, PROKKA_00641, PROKKA_03722, PROKKA_03738                                                                       |
| 7 | GO:00042819 | Vitamin B6 biosynthetic process  | Biological_process | 4  | PROKKA_00111, PROKKA_04360, PROKKA_03934, PROKKA_04237                                                                                                                                                                                                     |
| 7 | GO:0009234  | Menaquinone biosynthetic process | Biological_process | 4  | PROKKA_02521, PROKKA_01110, PROKKA_03686, PROKKA_02963                                                                                                                                                                                                     |
| 7 | GO:0009231  | Riboflavin biosynthetic process  | Biological_process | 6  | PROKKA_04386, PROKKA_04325, PROKKA_04388, PROKKA_03917, PROKKA_04389, PROKKA_04387                                                                                                                                                                         |
| 7 | GO:0009228  | Thiamine biosynthetic process    | Biological_process | 6  | PROKKA_03752, PROKKA_03872, PROKKA_04338, PROKKA_00363, PROKKA_02746, PROKKA_02467                                                                                                                                                                         |

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**Table S4** The possibly partial important genes or gene clusters for strain JXJ CY 53<sup>T</sup> to provide MF-905 with available P and N

| Level | GO         | Term                              | Ontology           | Gene_num | Gene_list                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-------|------------|-----------------------------------|--------------------|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5     | GO:0016053 | Organic acid biosynthetic process | Biological process | 162      | PROKKA_03876, PROKKA_00379, PROKKA_00061, PROKKA_03412, PROKKA_03291, PROKKA_00380, PROKKA_03843, PROKKA_00653, PROKKA_03152, PROKKA_03309, PROKKA_02429, PROKKA_03417, PROKKA_00863, PROKKA_00606, PROKKA_00277, PROKKA_03627, PROKKA_01943, PROKKA_03549, PROKKA_00328, PROKKA_03968, PROKKA_04238, PROKKA_02406, PROKKA_00401, PROKKA_02663, PROKKA_03933, PROKKA_01773, PROKKA_01930, PROKKA_03865, PROKKA_02639, PROKKA_03900, PROKKA_02923, PROKKA_00399, PROKKA_03932, PROKKA_00865, PROKKA_03027, PROKKA_00935, PROKKA_02009, PROKKA_00254, PROKKA_01134, PROKKA_01719, PROKKA_03283, PROKKA_03617, PROKKA_04244, PROKKA_03419, PROKKA_01836, PROKKA_02627, PROKKA_02511, PROKKA_03771, PROKKA_02997, PROKKA_03392, PROKKA_03884, PROKKA_00387, PROKKA_00022, PROKKA_01610, PROKKA_01101, PROKKA_03415, PROKKA_02987, PROKKA_02401, PROKKA_02720, PROKKA_03477, PROKKA_00420, PROKKA_02736, PROKKA_04225, PROKKA_01965, PROKKA_02428, PROKKA_02458, PROKKA_00994, PROKKA_03281, PROKKA_04403, PROKKA_03407, PROKKA_02995, PROKKA_04249, PROKKA_00913, PROKKA_01202, PROKKA_04414, PROKKA_02937, PROKKA_02968, PROKKA_02614, PROKKA_00469, PROKKA_04371, PROKKA_03385, PROKKA_00143, PROKKA_01774, PROKKA_02743, PROKKA_04050, PROKKA_02856, PROKKA_00032, PROKKA_02438, PROKKA_03643, PROKKA_02403, PROKKA_04402, PROKKA_03279, PROKKA_03284, PROKKA_03416, PROKKA_01741, PROKKA_04219, PROKKA_01551, PROKKA_02008, PROKKA_03219, PROKKA_03890, PROKKA_00453, PROKKA_03441, PROKKA_00373, PROKKA_01906, PROKKA_03396, PROKKA_00015, PROKKA_03305, PROKKA_01177, PROKKA_03934, PROKKA_02969, PROKKA_00293, PROKKA_02985, PROKKA_04245, PROKKA_03846, PROKKA_02990, |

|   |            |                                                 |                    |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|---|------------|-------------------------------------------------|--------------------|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|   |            |                                                 |                    |    | PROKKA_02986, PROKKA_03112, PROKKA_02690, PROKKA_02974, PROKKA_00486, PROKKA_01757, PROKKA_01833, PROKKA_00866, PROKKA_04310, PROKKA_01104, PROKKA_00867, PROKKA_03387, PROKKA_02047, PROKKA_03110, PROKKA_00033, PROKKA_03988, PROKKA_00951, PROKKA_03585, PROKKA_03465, PROKKA_03750, PROKKA_04298, PROKKA_01105, PROKKA_02618, PROKKA_02409, PROKKA_03673, PROKKA_03457, PROKKA_03940, PROKKA_00327, PROKKA_04037, PROKKA_03006, PROKKA_01864, PROKKA_01131, PROKKA_03391, PROKKA_03797, PROKKA_00381, PROKKA_03029, PROKKA_01947, PROKKA_00489, PROKKA_00918, PROKKA_02024, PROKKA_04327, PROKKA_04079, PROKKA_04377, PROKKA_02455, PROKKA_03751, PROKKA_03386, PROKKA_04287 |
| 4 | GO:0015849 | Organic acid transport                          | Biological_process | 4  | PROKKA_03036, PROKKA_03478, PROKKA_04070, PROKKA_00493                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 5 | GO:0005342 | Organic acid transmembrane transporter activity | Molecular_function | 15 | PROKKA_03500, PROKKA_01546, PROKKA_03380, PROKKA_03619, PROKKA_02749, PROKKA_00617, PROKKA_03138, PROKKA_03769, PROKKA_00570, PROKKA_01987, PROKKA_01588, PROKKA_04018, PROKKA_03483, PROKKA_01013, PROKKA_03098                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 6 | GO:0016791 | Phosphatase activity                            | Molecular_function | 26 | PROKKA_03874, PROKKA_01756, PROKKA_01585, PROKKA_01578, PROKKA_02697, PROKKA_03900, PROKKA_03706, PROKKA_03149, PROKKA_03072, PROKKA_04370, PROKKA_00624, PROKKA_04075, PROKKA_00359, PROKKA_02004, PROKKA_03896, PROKKA_02860, PROKKA_01080, PROKKA_04253, PROKKA_01654, PROKKA_00918, PROKKA_04245, PROKKA_02655, PROKKA_02992, PROKKA_03419, PROKKA_03032, PROKKA_02313                                                                                                                                                                                                                                                                                                       |
| 7 | GO:0003993 | Acid phosphatase activity                       | Molecular_function | 5  | PROKKA_04253, PROKKA_01756, PROKKA_03072, PROKKA_02992, PROKKA_02004                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

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|---|------------|-------------------------------|--------------------|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7 | GO:0004035 | Alkaline phosphatase activity | Molecular function | 1  | PROKKA_01654                                                                                                                                                                                                                                                                                                                                                                                           |
| 5 | GO:0009877 | Nodulation                    | Biological process | 10 | PROKKA_03281, PROKKA_01154, PROKKA_03661, PROKKA_01806, PROKKA_01056, PROKKA_00028, PROKKA_04290, PROKKA_01165, PROKKA_02505, PROKKA_02453, PROKKA_04330, PROKKA_01127, PROKKA_00663, PROKKA_00137, PROKKA_02592, PROKKA_00662, PROKKA_03707, PROKKA_03361, PROKKA_03824, PROKKA_00136, PROKKA_00138, PROKKA_02234, PROKKA_01758, PROKKA_02233, PROKKA_00660, PROKKA_02235, PROKKA_00135, PROKKA_01757 |
| 5 | GO:0009399 | nitrogen fixation             | Biological process | 18 |                                                                                                                                                                                                                                                                                                                                                                                                        |

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