Whole-Genome Sequences of 94 Environmental Isolates of Bacillus cereus Sensu Lato

Géraldine A. Van der Auwera,a,b Michael Feldgarden,b Roberto Kolter,c Jacques Mahillonaproducts and/or services for Genome Announcements. The authors declare that they have no other relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript. This includes employment, consultancies, honoraria, stock ownership or options, expert testimony, grants or patents received or pending, or royalties.

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Bacillus cereus sensu lato is a species complex that includes the anthrax pathogen Bacillus anthracis and other bacterial species of medical, industrial, and ecological importance. Their phenotypes of interest are typically linked to large plasmids that are closely related to the anthrax plasmids pXO1 and pXO2. Here, we present the draft genome sequences of 94 isolates of B. cereus sensu lato, which were chosen for their plasmid content and environmental origins.

We have shown previously that select sequences of the shared pXO1 and pXO2 backbones can be found widely in environmental isolates of B. cereus sensu lato (10). We postulated that these are found in plasmids that are genetically related to the pXO1 and pXO2 plasmids (hence called pXO1-like and pXO2-like, respectively) and may play an important role in the ecotypic and pathotypic differentiation of B. cereus sensu lato organisms.

In order to gain deeper insight into the ecological distribution and genomic diversity of the pXO1-like and pXO2-like plasmids, we sequenced a panel of 94 isolates of B. cereus sensu lato organisms containing a variety of plasmids and having diverse environmental origins. This adds to the ~60 whole or draft genomes of B. cereus of various origins already available in GenBank.

De novo assemblies were generated from Illumina 101-base paired-end reads generated with two libraries, one from 180-bp fragments and one from 3-kb jumping libraries. The assemblies were constructed using AllPaths-LG (11). The protein-coding genes were predicted with Prodigal (12) and filtered to remove genes with ≥70% overlap to the tRNAs or rRNAs. The tRNAs were identified by tRNAscan-SE (13). The rRNA genes were predicted using RNAScanner (14). The gene product names were assigned based on top BLAST hits against the Swiss-Prot protein database (≥70% identity and ≥70% query coverage) and a protein family profile search against the TIGRFam HMMER equivalogs.

Nucleotide sequence accession numbers. All 94 draft genome sequences have been deposited at GenBank under the accession numbers.

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| Sample source          | Strain name   | GenBank accession no. | Predicted plasmid(s) | Reference               |
|-----------------------|--------------|-----------------------|----------------------|-------------------------|
| Soil, Greenland       | VD048        | AHEU010000000         | pXO1                 | 10                      |
|                       | VD078        | AHVE010000000         | pXO1                 | 10                      |
|                       | VD045        | AHEI010000000         | pXO2                 | 10                      |
|                       | VDM022       | AHFP010000000         | pXO2                 | 10                      |
|                       | VDM021       | AHFU010000000         | Neither              | 10                      |
|                       | VDM019       | AHFO010000000         | Neither              | 10                      |
| Soil, Spain           | VD014        | AHER010000000         | pXO1                 | 10                      |
|                       | VDM006       | AHFT010000000         | pXO2                 | 10                      |
|                       | VDM034       | AHFO010000000         | Neither              | 10                      |
| Soil, Scotland        | VD142        | AHCL010000000         | pXO2                 | 10                      |
|                       | VD148        | AHFP010000000         | pXO2                 | 10                      |
|                       | VDM062       | AHSF010000000         | pXO2                 | 10                      |
|                       | VD136        | AHFC010000000         | Neither              | 10                      |
|                       | VD140        | AHD010000000          | Neither              | 10                      |
|                       | VD146        | AHEF010000000         | Neither              | 10                      |
| Water, Scotland       | VD200        | AHFM010000000         | pXO1                 | 10                      |
|                       | VD214        | AHFN010000000         | Neither              | 10                      |
| Soil, Martinique      | VD133        | AHFB010000000         | pXO1                 | 10                      |
|                       | VD131        | AHFA010000000         | Neither              | 10                      |
| Soil, Guadeloupe      | VD107        | AHEX010000000         | pXO2                 | 10                      |
|                       | VD115        | AHEY010000000         | pXO2                 | 10                      |
|                       | VD102        | AHEW010000000         | Neither              | 10                      |
|                       | VD118        | AHEZ010000000         | Neither              | 10                      |
| Soil, Abu Dhabi, UAE  | VD156        | AHFH010000000         | pXO1                 | 10                      |
|                       | VD154        | AHFG010000000         | Neither              | 10                      |
| Soil, Dubai, UAE      | VD169        | AHFO100000000         | pXO1                 | 10                      |
|                       | VD196        | AHFL010000000         | pXO1                 | 10                      |
|                       | VD166        | AHFI010000000         | Neither              | 10                      |
|                       | VD184        | AHFK010000000         | Neither              | 10                      |
| Water, Belgium (small pond site) | VD021 | AHE100000000         | pXO2                 | 10                      |
|                       | VD022        | AHG010000000         | pXO1, pXO2           | 10                      |
|                       | VDM053       | AHFR010000000         | Neither              | 10                      |
| Soil, Belgium (site A) | HuA2-1     | AHDV010000000         | pXO1                 | 10                      |
|                       | HuA2-3       | AHDW010000000         | Neither              | 10                      |
|                       | HuA2-4       | AHDX010000000         | pXO2                 | 10                      |
|                       | HuA2-9       | AHDY010000000         | Neither              | 10                      |
|                       | HuA3-9       | AHDZ010000000         | pXO1                 | 10                      |
|                       | HuA4-10      | AHEA010000000         | pXO2                 | 10                      |
| Soil, Belgium (site B) | HuB1-1     | AHEB010000000         | Neither              | 10                      |
|                       | HuB2-9       | AHEG010000000         | pXO2                 | 10                      |
|                       | HuB4-4       | AHEC010000000         | Neither              | 10                      |
|                       | HuB4-10      | AHEG010000000         | pXO2                 | 10                      |
|                       | HuB5-5       | AHEC010000000         | pXO2                 | 10                      |
|                       | HuB13-1      | AHEF010000000         | Neither              | 10                      |
| Soil, Massachusetts (Boston site AG) | BAG10-1 | AHCN010000000 | Neither | This study |
|                       | BAG10-2      | AHCN010000000         | Neither              | This study |
|                       | BAG10-3      | AHCN010000000         | Neither              | This study |
|                       | BAG1X1-1     | AHCN010000000         | pXO1                 | This study |
|                       | BAG1X1-2     | AHCN010000000         | pXO1                 | This study |
|                       | BAG1X1-3     | AHCN010000000         | pXO1                 | This study |
|                       | BAG1X2-1     | AHCN010000000         | pXO1, pXO2           | This study |
|                       | BAG1X2-2     | AHCN010000000         | pXO2                 | This study |
|                       | BAG1X2-3     | AHCN010000000         | pXO2                 | This study |

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Table 1 (Continued)

| Sample source                | Strain name | GenBank accession no. | Predicted plasmid(s) | Reference                                      |
|------------------------------|-------------|------------------------|----------------------|------------------------------------------------|
| Soil, Massachusetts (Boston site ES) | BAG6O-1   | AHDW010000000          | Neither              | This study                                     |
|                              | BAG6O-2    | AHDW01000000           | Neither              | This study                                     |
|                              | BAG6X1-1   | AHDW01000000           | pXO1                 | This study                                     |
|                              | BAG6X1-2   | AHDW01000000           | pXO1                 | This study                                     |
| Food                         | AND1407    | AHCW01000000000        | pXO1                 | 15                                             |
|                              | K-5975c    | AHCW01000000           | pXO1                 | 19                                             |
|                              | TIA2C19    | AHCW01000000           | pXO1                 | 20                                             |
|                              | Schrouff   | AHCW01000000           | pXO1, pXO2           | Mahillon et al., unpublished                   |
|                              | ISP3191    | AHCW01000000           | pXO1, pXO2           | Dierick et al., unpublished                    |
|                              | ISP2954    | AHCW01000000           | pXO1                 | Dierick et al., unpublished                    |
| Soil, China                  | B5-2       | AHDW01000000           | pXO1, pXO2           | Sun et al., unpublished                        |
|                              | IS075      | AHCW01000000           | pXO1, pXO2           | 21                                             |
|                              | IS195      | AHCW01000000           | pXO1, pXO2           | 21                                             |
|                              | IS845/00   | AHCW01000000           | pXO1                 | 21                                             |
| Insect<sup>a</sup>           | HD73       | AHDW01000000           | pXO2                 | 22                                             |
| Various origins<sup>b</sup>  | MG67       | AHCW01000000           | Other                | 17                                             |
|                              | MC118      | AHCW01000000           | Other                | 17                                             |
|                              | MSX-A1     | AHCW01000000           | Other                | 16                                             |
|                              | MSX-A12    | AHCW01000000           | Other                | 16                                             |
|                              | MSX-D12    | AHCW01000000           | Other                | 16                                             |
|                              | BMG1.7     | AHCW01000000           | Other                | 18                                             |
| Various origins<sup>c</sup>  | CER057     | AHDW01000000           | Other                | 15                                             |
|                              | CER074     | AHDW01000000           | Other                | 15                                             |
|                              | BtB2-4     | AHDW01000000           | Other                | 15                                             |

<sup>a</sup> Reference strain for the pXO2-like plasmid pAW63.

<sup>b</sup> Strains predicted to carry other plasmids of interest.

<sup>c</sup> Strains predicted to carry plasmid fragments on the chromosome.

<sup>d</sup> Neither, neither pXO1 nor pXO2; other, plasmids other than pXO1 or pXO2.
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