

Supplementary data

Whole-genome analysis reveals that bacteriophages promote environmental adaptation of
Staphylococcus aureus via gene exchange, acquisition, and loss

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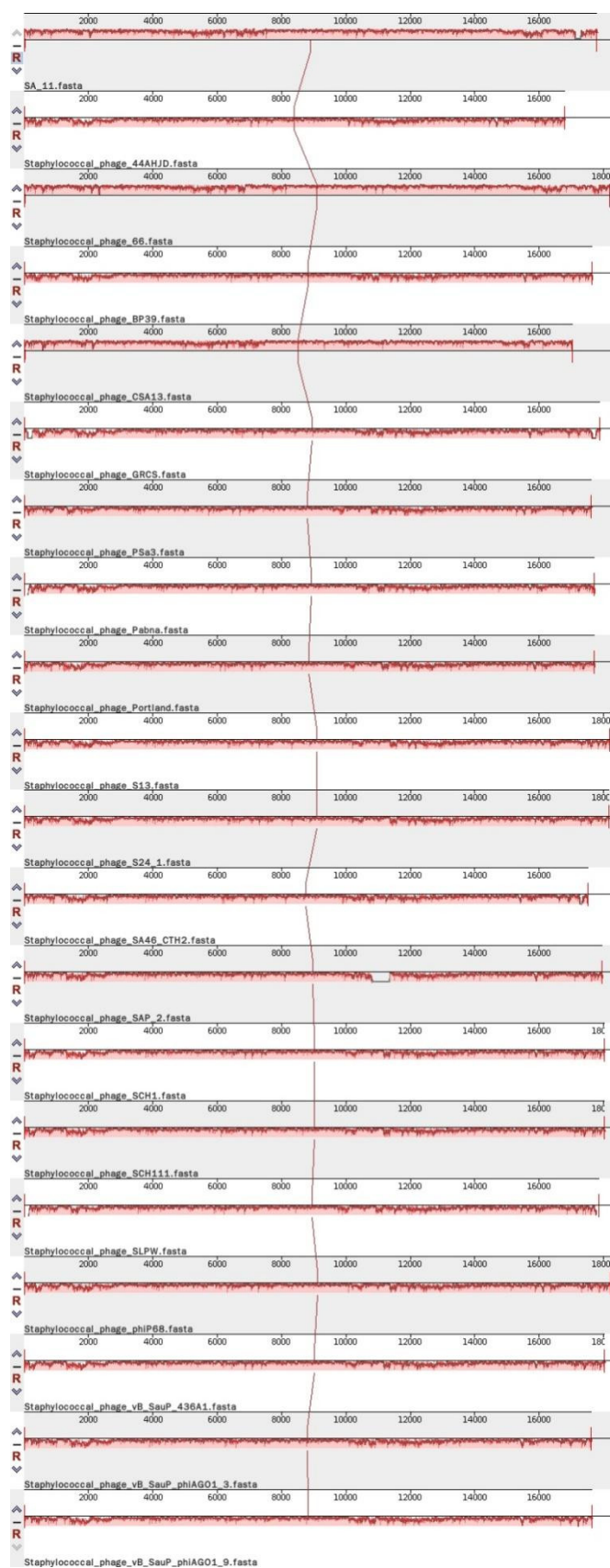


Figure S1. MARVE analysis of genomes of 20 Podoviridae phages in lineage I.

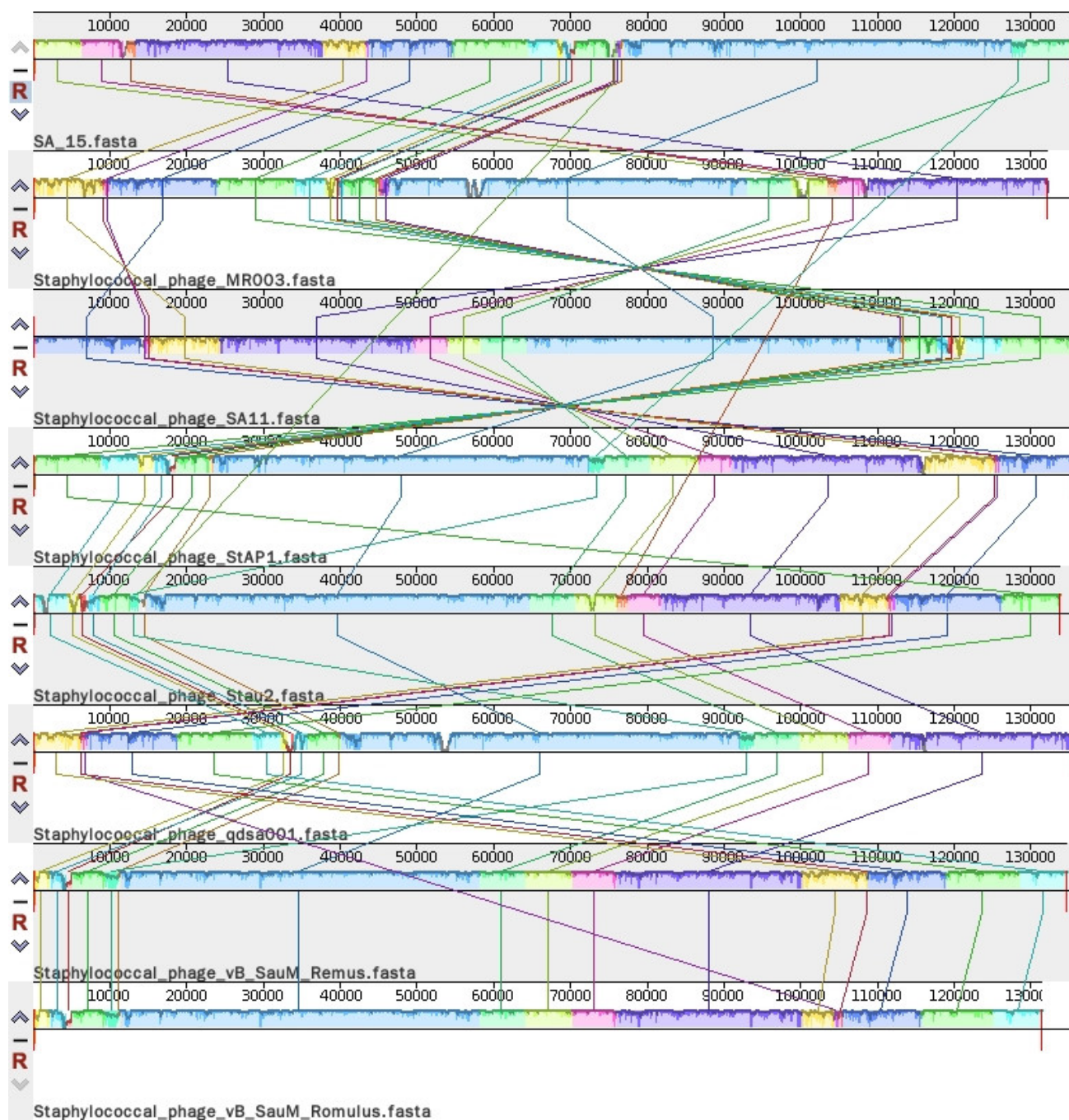


Figure S2. MARVE analysis of genomes of 8 Herelleviridae phages in clade IIa (lineage II).

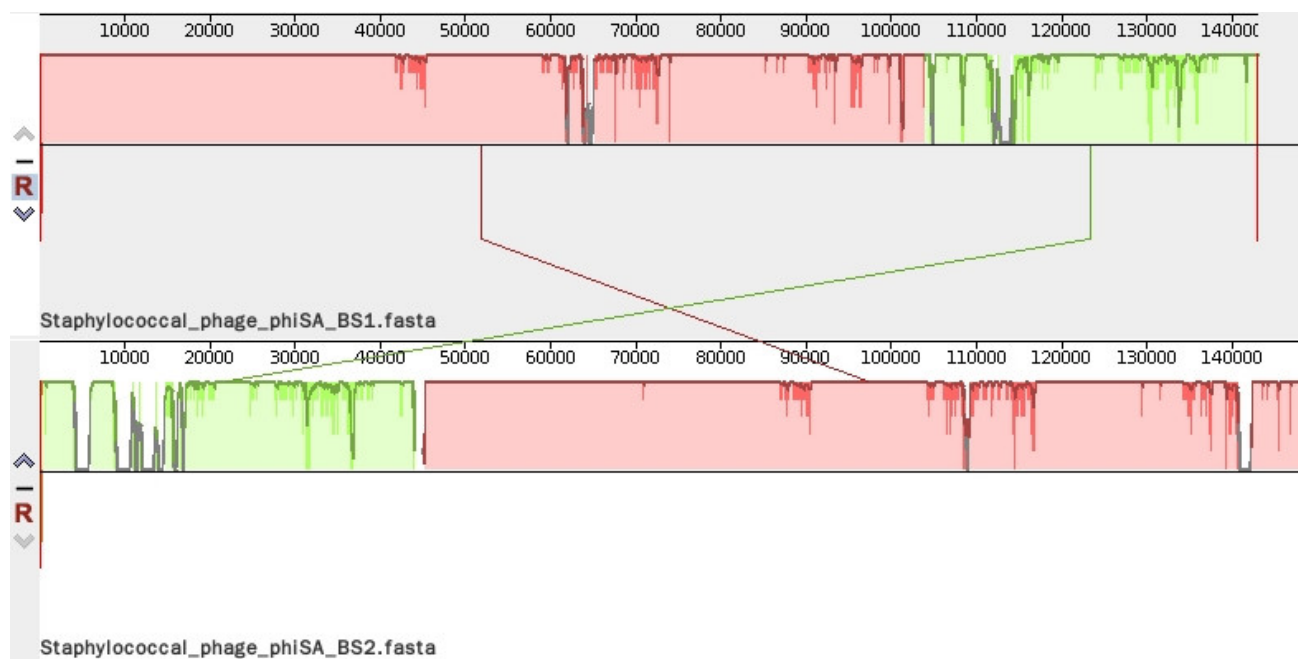


Figure S3. MARVE analysis of genomes of 2 Herelleviridae phages in clade IIb (lineage II).

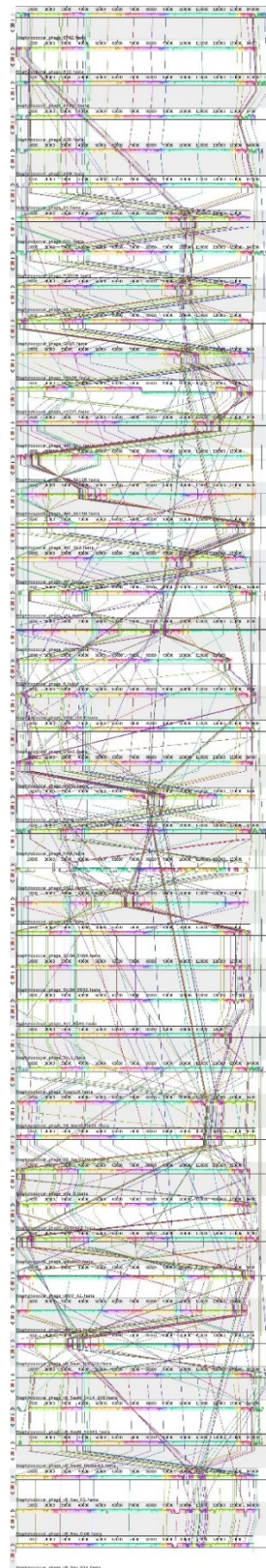


Figure S4. MARVE analysis of genomes of 46 Herelleviridae phages in clade IIe (lineage II).

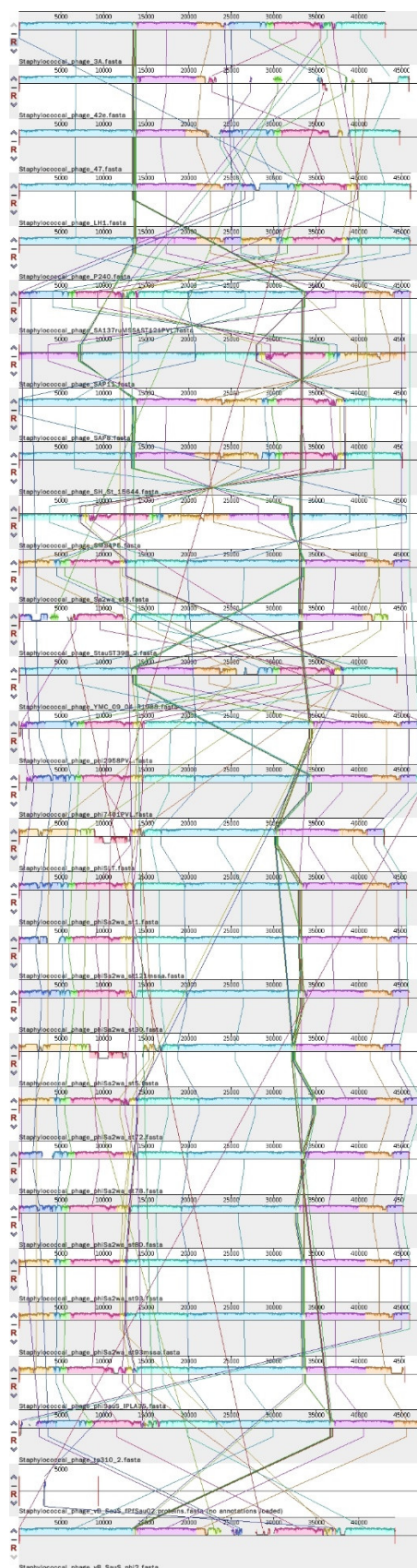


Figure S5. MARVE analysis of genomes of 29 Siphoviridae phages in clade IIIa (lineage III).

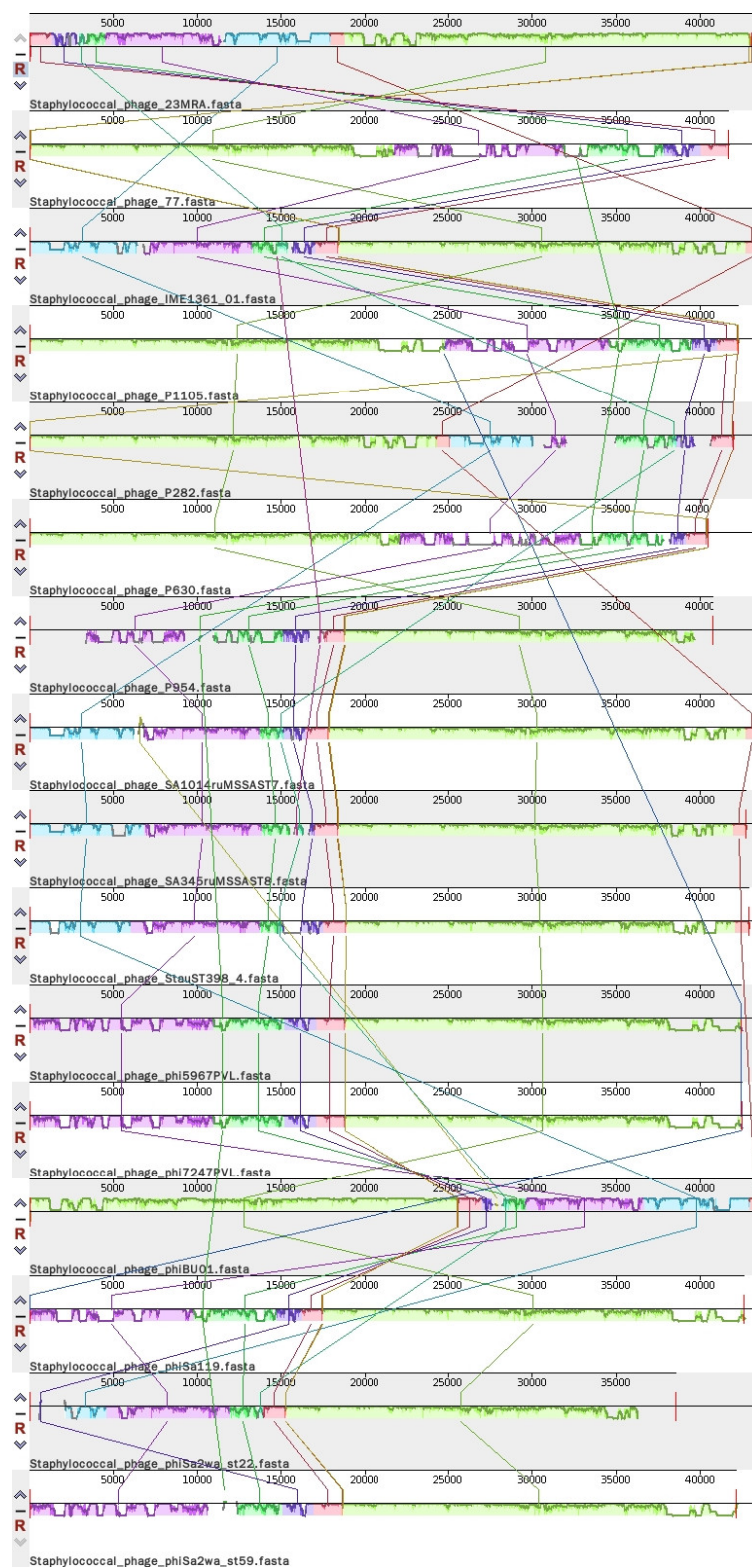


Figure S6. MARVE analysis of genomes of 16 Siphoviridae phages in clade IIIb (lineage III).

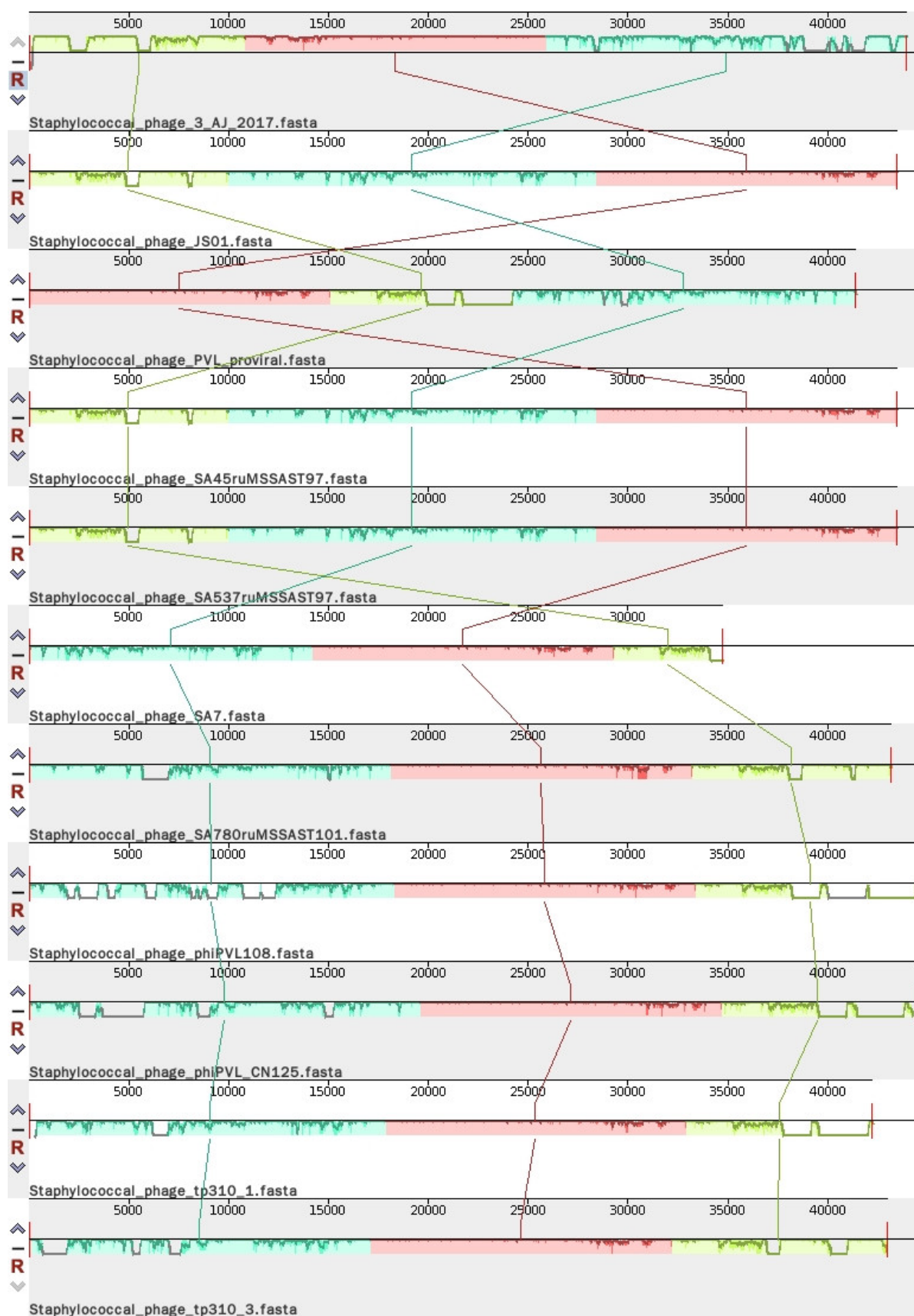


Figure S7. MARVE analysis of genomes of 11 Siphoviridae phages in clade IIIc (lineage III).

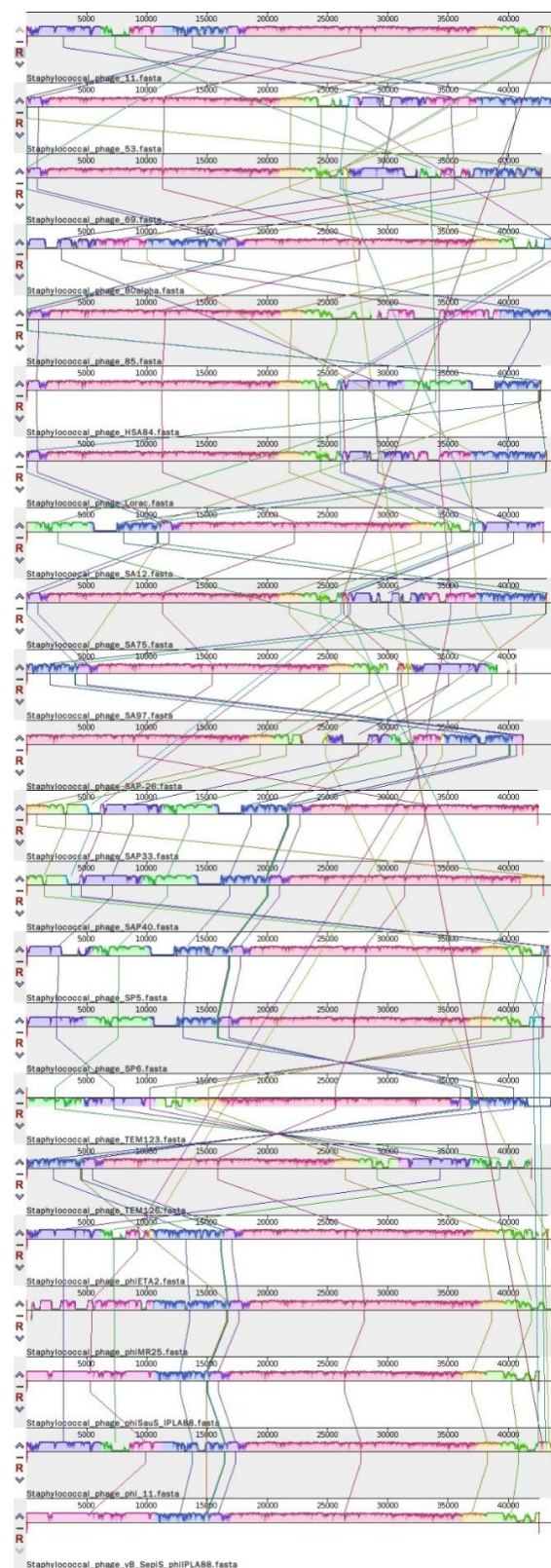


Figure S8. MARVE analysis of genomes of 22 Siphoviridae phages in clade IIId (lineage III).

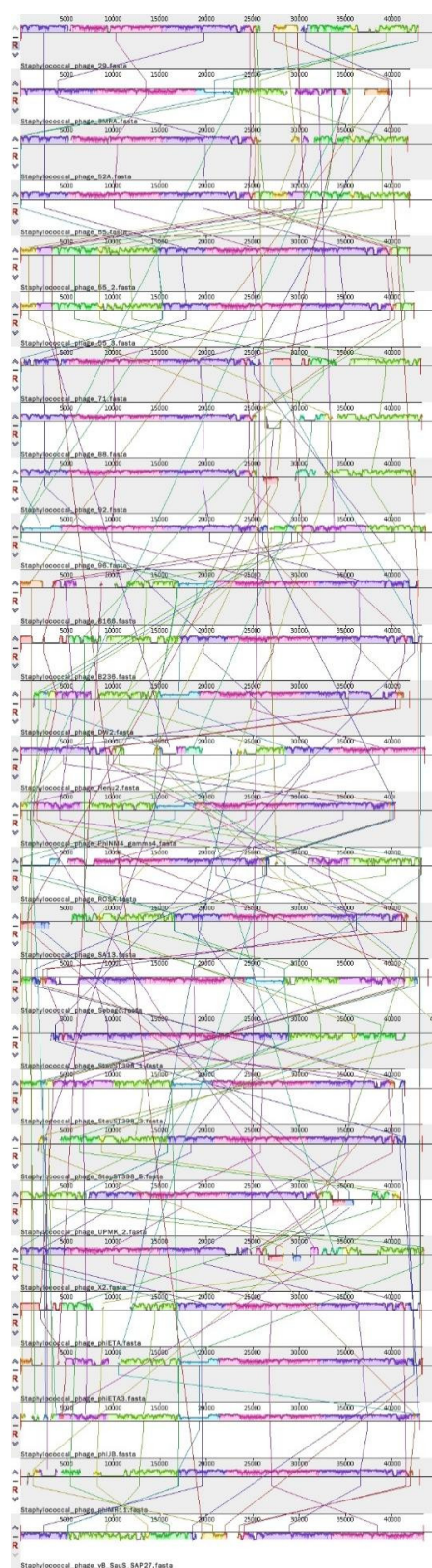


Figure S9. MARVE analysis of genomes of 28 Siphoviridae phages in clade IIIe (lineage III).

Table S1. Metadata for 189 phages publicly available on NCBI. The 189 phages comprise four data sets including genomes of 20 Podoviridae phages, 56 Herelleviridae phages, 112 Siphoviridae phages, and 1 Erwinia phage phiEa2809 as the outgroup.

| Strain | Genome length (bp) | GC content (%) | ORFs | tRNA | Isolation date | Geographic region | Organism | Isolation source | Genebank Accession |
|------------------------------------|--------------------|----------------|------|------|----------------|-------------------|--------------|--------------------|--------------------|
| <i>Staphylococcus aureus</i> phage | | | | | | | | | |
| DW2 | 41941 | 29.0 | 64 | 0 | Unknown | Ireland | Siphoviridae | Sewage | NC_024391.1 |
| 3MRA | 41931 | 35.4 | 67 | 0 | Unknown | United State | Siphoviridae | Human | NC_028917.1 |
| 23MRA | 43098 | 32.9 | 68 | 0 | Unknown | United State | Siphoviridae | Human | NC_028775.1 |
| SMSAP5 | 45552 | 33.4 | 65 | 0 | 2010 | South Korea | Siphoviridae | Unknown | NC_019513.1 |
| LH1 | 46048 | 33.2 | 61 | 0 | 2009 | Canada | Siphoviridae | Unknown | JX174275.1 |
| vB_SauS_fPfSau02 | 45108 | 33.7 | 69 | 0 | Unknown | Finland | Siphoviridae | Unknown | MK348510.1 |
| tp310_1 | 42232 | 33.5 | 57 | 0 | Unknown | United State | Siphoviridae | Unknown | NC_009761.3 |
| 3_AJ_2017 | 43922 | 33.3 | 66 | 0 | 2017 | Colombia | Siphoviridae | Human | KX232515.1 |
| phiSauS_IPLA88 | 42526 | 34.9 | 63 | 0 | Unknown | United State | Siphoviridae | Unknown | NC_011614.1 |
| phiSauS_IPLA35 | 45344 | 33.2 | 64 | 0 | Unknown | United State | Siphoviridae | Unknown | NC_011612.1 |
| phiPVL108 | 44857 | 33.5 | 68 | 0 | Unknown | United State | Siphoviridae | Unknown | NC_008689.1 |
| tp310_3 | 42973 | 33.5 | 73 | 0 | Unknown | United State | Siphoviridae | Unknown | NC_009763.3 |
| tp310_2 | 47785 | 33.8 | 70 | 0 | Unknown | United State | Siphoviridae | Unknown | NC_009762.3 |
| phiSLT | 42942 | 33.3 | 70 | 0 | Unknown | Japan | Siphoviridae | Unknown | AB045978.2 |
| Sebago | 43878 | 35.3 | 68 | 0 | 2017 | United State | Siphoviridae | Environmental swab | MK618716.1 |
| Lorac | 43147 | 34.5 | 67 | 0 | 2015 | United State | Siphoviridae | Sewage | MH321492.1 |
| vB_SauS_SAP27 | 43444 | 35.0 | 69 | 0 | Unknown | South Korea | Siphoviridae | Unknown | MN904510.1 |
| SA75 | 43134 | 34.4 | 66 | 0 | Unknown | South Korea | Siphoviridae | Feces | MT013111.1 |

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|--------------------|-------|------|-----|---|---------|-------------------|--------------|---------|-------------|
| phi_11 | 43604 | 34.5 | 67 | 0 | Unknown | United State | Siphoviridae | Unknown | AF424781.1 |
| vB_SepiS_phiIPLA88 | 42526 | 34.9 | 63 | 0 | Unknown | Spain | Siphoviridae | Unknown | EU861004.1 |
| Sa2wa_st8 | 45914 | 33.1 | 63 | 0 | 2008 | Australia | Siphoviridae | Human | MK940809.1 |
| SAP40 | 42911 | 34.0 | 63 | 0 | Unknown | Republic of Korea | Siphoviridae | Unknown | MK801683.1 |
| SAP33 | 42414 | 34.0 | 64 | 0 | Unknown | Republic of Korea | Siphoviridae | Unknown | MK801682.1 |
| SAP11 | 45346 | 33.4 | 65 | 0 | Unknown | Republic of Korea | Siphoviridae | Unknown | MK801681.1 |
| SAP8 | 45533 | 33.4 | 65 | 0 | Unknown | Republic of Korea | Siphoviridae | Unknown | MK801680.1 |
| Henu2 | 43513 | 35.0 | 64 | 0 | 2017 | China | Siphoviridae | Sewage | MK211557.1 |
| VB_SauS_SA2 | 89055 | 31.9 | 131 | 1 | Unknown | China | Siphoviridae | Unknown | MH356730.1 |
| HSA84 | 42650 | 34.5 | 60 | 0 | Unknown | Republic of Korea | Siphoviridae | Unknown | MG557619.1 |
| SA780ruMSSAST101 | 43184 | 33.5 | 65 | 0 | 2015 | Russia | Siphoviridae | Human | MH384260.1 |
| SA97 | 40592 | 34.2 | 61 | 0 | Unknown | South Korea | Siphoviridae | Unknown | NC_029010.1 |
| B236 | 43228 | 35.6 | 66 | 0 | 2013 | Czech Republic | Siphoviridae | Unknown | NC_028915.1 |
| vB_SauS_phi2 | 44222 | 33.7 | 61 | 0 | 2011 | Canada | Siphoviridae | Unknown | NC_028862.1 |
| B166 | 42881 | 34.8 | 64 | 0 | 2012 | Czech Republic | Siphoviridae | Unknown | NC_028859.1 |
| phiJB | 43012 | 34.7 | 69 | 0 | 2011 | Czech Republic | Siphoviridae | Unknown | NC_028669.1 |
| phiBU01 | 43748 | 33.0 | 67 | 0 | Unknown | United State | Siphoviridae | Unknown | NC_026016.1 |
| phiSa119 | 42600 | 33.4 | 67 | 0 | Unknown | United State | Siphoviridae | Unknown | NC_025460.1 |
| StauST398_5 | 43301 | 35.2 | 66 | 0 | Unknown | United State | Siphoviridae | Unknown | NC_023500.1 |
| StauST398_4 | 42906 | 33.1 | 61 | 0 | Unknown | Switzerland | Siphoviridae | Unknown | NC_023499.1 |
| YMC_09_04_R1988 | 44459 | 33.3 | 61 | 0 | Unknown | United State | Siphoviridae | Unknown | NC_022758.1 |
| JS01 | 43458 | 33.3 | 63 | 0 | Unknown | China | Siphoviridae | Milk | NC_021773.2 |
| SA13 | 42652 | 35.4 | 66 | 0 | Unknown | United State | Siphoviridae | Unknown | NC_021863.1 |
| SA12 | 42902 | 34.5 | 61 | 0 | Unknown | United State | Siphoviridae | Unknown | NC_021801.1 |
| StauST398_3 | 41392 | 35.6 | 68 | 0 | 2011 | France | Siphoviridae | Unknown | NC_021332.1 |

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|---------------------|-------|------|----|---|---------|--------------|--------------|----------|-------------|
| StauST398_1 | 45242 | 34.5 | 71 | 0 | 2011 | France | Siphoviridae | Unknown | NC_021326.1 |
| StauST398_2 | 45572 | 33.4 | 61 | 0 | 2011 | France | Siphoviridae | Unknown | NC_021323.1 |
| phi7401PVL | 47252 | 33.1 | 67 | 0 | Unknown | United State | Siphoviridae | Unknown | NC_020199.1 |
| phi5967PVL | 42461 | 33.3 | 74 | 0 | Unknown | United State | Siphoviridae | Unknown | NC_019921.1 |
| TEM123 | 43786 | 34.1 | 64 | 0 | 2011 | South Korea | Siphoviridae | Unknown | NC_017968.1 |
| P954 | 40761 | 34.0 | 64 | 0 | 2002 | India | Siphoviridae | Unknown | NC_013195.1 |
| phiPVL_CN125 | 44492 | 33.6 | 82 | 0 | Unknown | United State | Siphoviridae | Unknown | NC_012784.1 |
| phi2958PVL | 47342 | 33.0 | 65 | 0 | Unknown | United State | Siphoviridae | Hospital | NC_011344.1 |
| ROSA | 43155 | 35.1 | 70 | 0 | Unknown | United State | Siphoviridae | Unknown | NC_007058.1 |
| 2638A | 41318 | 36.9 | 56 | 0 | Unknown | United State | Siphoviridae | Unknown | NC_007051.1 |
| PVL_proviral | 41401 | 33.5 | 63 | 0 | Unknown | United State | Siphoviridae | Unknown | NC_002321.1 |
| SA137ruMSSAST121PVL | 45999 | 33.3 | 63 | 0 | 2007 | Russia | Siphoviridae | Human | MH384261.1 |
| SA1014ruMSSAST7 | 43504 | 33.1 | 63 | 0 | 2015 | Russia | Siphoviridae | Human | MH384259.1 |
| SH_St_15644 | 45111 | 33.4 | 64 | 0 | Unknown | China | Siphoviridae | Sewage | MG770897.1 |
| phiSa2wa_st121mssa | 45621 | 33.1 | 61 | 0 | 1995 | Australia | Siphoviridae | Unknown | MG029518.1 |
| phiSa2wa_st93 | 45913 | 33.1 | 64 | 0 | 2003 | Australia | Siphoviridae | Human | MG029517.1 |
| phiSa2wa_st93mssa | 45913 | 33.1 | 64 | 0 | 1995 | Australia | Siphoviridae | Unknown | MG029516.1 |
| phiSa2wa_st80 | 45164 | 33.3 | 62 | 0 | 2005 | Australia | Siphoviridae | Human | MG029515.1 |
| phiSa2wa_st78 | 45878 | 33.2 | 65 | 0 | 2008 | Australia | Siphoviridae | Human | MG029514.1 |
| phiSa2wa_st72 | 47213 | 33.2 | 67 | 0 | 2006 | Australia | Siphoviridae | Human | MG029513.1 |
| phiSa2wa_st59 | 42133 | 33.3 | 72 | 0 | 2003 | Australia | Siphoviridae | Human | MG029512.1 |
| phiSa2wa_st30 | 45780 | 33.5 | 61 | 0 | 2002 | Australia | Siphoviridae | Human | MG029511.1 |
| phiSa2wa_st22 | 38576 | 33.2 | 51 | 0 | 2007 | Australia | Siphoviridae | Human | MG029510.1 |
| phiSa2wa_st5 | 44823 | 33.4 | 72 | 0 | 2008 | Australia | Siphoviridae | Human | MG029509.1 |
| UPMK_2 | 40955 | 35.4 | 64 | 0 | Unknown | Malaysia | Siphoviridae | Water | MG564297.1 |

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|---------------|-------|------|----|---|---------|----------------|--------------|---------|-------------|
| phiSa2wa_st1 | 45585 | 33.3 | 61 | 0 | 1995 | Australia | Siphoviridae | Human | MF580410.1 |
| P240 | 45985 | 33.1 | 67 | 0 | 2014 | Germany | Siphoviridae | Unknown | KY056620.1 |
| P1105 | 42282 | 33.5 | 68 | 0 | 2013 | Germany | Siphoviridae | Unknown | KT878766.1 |
| P630 | 40448 | 33.7 | 64 | 0 | 2015 | Germany | Siphoviridae | Unknown | KT809369.1 |
| P282 | 41960 | 33.0 | 69 | 0 | 2015 | Germany | Siphoviridae | Unknown | KT809368.1 |
| IME1361_01 | 43516 | 32.8 | 65 | 0 | Unknown | China | Siphoviridae | Unknown | KY653123.1 |
| SA7 | 34730 | 34.1 | 51 | 0 | Unknown | South Korea | Siphoviridae | Unknown | KY695153.1 |
| vB_SauS_IMEP5 | 44677 | 34.3 | 68 | 0 | 2015 | China | Siphoviridae | Unknown | KX156762.1 |
| 55_3 | 42309 | 35.6 | 65 | 0 | Unknown | United Kingdom | Siphoviridae | Unknown | KR709303.1 |
| 55_2 | 41898 | 35.8 | 63 | 0 | Unknown | United Kingdom | Siphoviridae | Unknown | KR709302.1 |
| PhiNM4_gamma4 | 40365 | 35.1 | 65 | 0 | Unknown | United State | Siphoviridae | Unknown | KP209285.1 |
| SP6 | 42902 | 34.5 | 61 | 0 | Unknown | South Korea | Siphoviridae | Swine | JX274647.1 |
| SP5 | 43305 | 34.5 | 64 | 0 | Unknown | South Korea | Siphoviridae | Swine | JX274646.1 |
| phi7247PVL | 42481 | 33.3 | 74 | 0 | Unknown | Japan | Siphoviridae | Unknown | AP011956.1 |
| TEM126 | 41882 | 33.7 | 62 | 0 | 2009 | South Korea | Siphoviridae | Unknown | HQ127381.1 |
| 55 | 41902 | 35.7 | 63 | 0 | Unknown | Canada | Siphoviridae | Unknown | NC_007060.1 |
| 37 | 43681 | 35.1 | 65 | 0 | Unknown | Canada | Siphoviridae | Unknown | NC_007055.1 |
| 3A | 43095 | 33.5 | 62 | 0 | Unknown | Canada | Siphoviridae | Unknown | NC_007053.1 |
| 77 | 41708 | 33.5 | 69 | 0 | Unknown | Canada | Siphoviridae | Unknown | NC_005356.1 |
| SAP-26 | 41207 | 34.0 | 66 | 0 | Unknown | South Korea | Siphoviridae | Unknown | NC_014460.1 |
| phiMR25 | 44342 | 34.3 | 72 | 0 | Unknown | Japan | Siphoviridae | Unknown | NC_010808.1 |
| phiMR11 | 43011 | 35.6 | 69 | 0 | Unknown | Japan | Siphoviridae | Unknown | NC_010147.1 |
| 80alpha | 43864 | 34.1 | 68 | 0 | Unknown | United State | Siphoviridae | Unknown | NC_009526.1 |
| phiETA3 | 43282 | 34.9 | 67 | 0 | Unknown | Japan | Siphoviridae | Unknown | NC_008799.1 |
| phiETA2 | 43265 | 34.2 | 69 | 0 | Unknown | Japan | Siphoviridae | Unknown | NC_008798.1 |

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|------------------|--------|------|-----|---|---------|--------------|----------------|---------|-------------|
| 92 | 42431 | 35.7 | 63 | 0 | Unknown | Canada | Siphoviridae | Unknown | NC_007064.1 |
| 88 | 43231 | 35.5 | 66 | 0 | Unknown | Canada | Siphoviridae | Unknown | NC_007063.1 |
| 52A | 41690 | 35.5 | 58 | 0 | Unknown | Canada | Siphoviridae | Unknown | NC_007062.1 |
| 29 | 42802 | 35.3 | 65 | 0 | Unknown | Canada | Siphoviridae | Unknown | NC_007061.1 |
| 71 | 43114 | 35.2 | 66 | 0 | Unknown | Canada | Siphoviridae | Unknown | NC_007059.1 |
| 96 | 43576 | 35.0 | 71 | 0 | Unknown | Canada | Siphoviridae | Unknown | NC_007057.1 |
| EW | 45286 | 36.0 | 68 | 0 | Unknown | Canada | Siphoviridae | Unknown | NC_007056.1 |
| 47 | 44777 | 33.5 | 61 | 0 | Unknown | Canada | Siphoviridae | Unknown | NC_007054.1 |
| 42c | 45861 | 33.7 | 67 | 0 | Unknown | Canada | Siphoviridae | Unknown | NC_007052.1 |
| 53 | 43883 | 34.1 | 69 | 0 | Unknown | Canada | Siphoviridae | Unknown | NC_007049.1 |
| 69 | 42732 | 34.3 | 66 | 0 | Unknown | Canada | Siphoviridae | Unknown | NC_007048.1 |
| 187 | 39620 | 34.3 | 66 | 0 | Unknown | Canada | Siphoviridae | Unknown | NC_007047.1 |
| 85 | 44283 | 34.5 | 68 | 0 | Unknown | Canada | Siphoviridae | Unknown | NC_007050.1 |
| X2 | 43440 | 36.0 | 65 | 0 | Unknown | Canada | Siphoviridae | Unknown | NC_007065.1 |
| 11 | 43604 | 34.5 | 67 | 0 | Unknown | United State | Siphoviridae | Unknown | NC_004615.1 |
| phiETA | 43081 | 35.4 | 66 | 0 | Unknown | Japan | Siphoviridae | Unknown | AP001553.1 |
| SA345ruMSSAST8 | 42735 | 33.0 | 63 | 0 | 2015 | Russia | Siphoviridae | Human | MH401416.1 |
| SA537ruMSSAST97 | 43458 | 33.4 | 66 | 0 | 2015 | Russia | Siphoviridae | Human | MH401415.1 |
| SA45ruMSSAST97 | 43454 | 33.4 | 66 | 0 | 2007 | Russia | Siphoviridae | Human | MH401414.1 |
| MR003 | 132152 | 30.0 | 186 | 0 | 2018 | Japan | Herelleviridae | Sewage | AP019522.1 |
| 676Z | 148564 | 30.5 | 234 | 4 | Unknown | Poland | Herelleviridae | Unknown | JX080302.2 |
| A3R | 141018 | 30.5 | 214 | 4 | Unknown | Poland | Herelleviridae | Unknown | JX080301.2 |
| 812 | 142096 | 30.4 | 220 | 4 | 1957 | Germany | Herelleviridae | Unknown | NC_029080.1 |
| vB_SauM_fRuSau02 | 148464 | 30.2 | 234 | 4 | Unknown | Finland | Herelleviridae | Unknown | MF398190.1 |
| MSA6 | 148243 | 30.2 | 236 | 4 | Unknown | Poland | Herelleviridae | Unknown | JX080304.2 |

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|----------------|--------|------|-----|---|---------|--------------|----------------|--------------------|-------------|
| P4W | 147590 | 30.4 | 234 | 4 | Unknown | Poland | Herelleviridae | Unknown | JX080305.2 |
| Fi200W | 148481 | 30.4 | 234 | 4 | Unknown | Poland | Herelleviridae | Unknown | JX080303.2 |
| Staph1N | 145647 | 30.5 | 233 | 4 | Unknown | Poland | Herelleviridae | Unknown | JX080300.2 |
| A5W | 145542 | 30.5 | 233 | 4 | Unknown | Poland | Herelleviridae | Unknown | EU418428.2 |
| K | 127395 | 30.6 | 182 | 4 | Unknown | Ireland | Herelleviridae | Unknown | AY176327.1 |
| Sb1M_9832 | 138231 | 30.5 | 214 | 4 | Unknown | United State | Herelleviridae | Unknown | MN336263.1 |
| Sb1M_6168 | 138231 | 30.5 | 214 | 4 | Unknown | United State | Herelleviridae | Unknown | MN336262.1 |
| Sb1_8383 | 139606 | 30.4 | 216 | 4 | Unknown | United State | Herelleviridae | Unknown | MN336261.1 |
| Sb_1 | 127188 | 30.4 | 182 | 4 | Unknown | United State | Herelleviridae | Unknown | NC_023009.1 |
| VB_SavM_JYL01 | 141384 | 30.2 | 223 | 4 | 2017 | China | Herelleviridae | Sewage | MH159197.1 |
| qdsa002 | 142499 | 30.3 | 228 | 4 | Unknown | China | Herelleviridae | Sewage | KY779849.1 |
| Maine | 141712 | 30.4 | 220 | 4 | 2018 | United State | Herelleviridae | Environmental swab | MN045228.1 |
| JD007 | 141836 | 30.3 | 223 | 4 | Unknown | China | Herelleviridae | Hospital | NC_019726.1 |
| phiSA012 | 142094 | 30.3 | 215 | 3 | Unknown | Japan | Herelleviridae | Unknown | NC_023573.1 |
| VB_SavM_JYL02 | 141384 | 30.2 | 224 | 4 | 2017 | China | Herelleviridae | Sewage | MK250904.1 |
| StAP1 | 135502 | 30.0 | 197 | 0 | 2013 | South Korea | Herelleviridae | Soil | KX532239.1 |
| Stau2 | 133798 | 30.0 | 188 | 0 | Unknown | China | Herelleviridae | Unknown | NC_030933.1 |
| SA11 | 136326 | 30.0 | 195 | 0 | 2009 | South Korea | Herelleviridae | Sewage | NC_019511.1 |
| B1 | 148884 | 30.2 | 237 | 4 | Unknown | Ireland | Herelleviridae | Unknown | MG656408.1 |
| JA1 | 147135 | 30.3 | 231 | 4 | Unknown | Ireland | Herelleviridae | Unknown | MF405094.1 |
| qdsa001 | 135563 | 29.8 | 195 | 0 | Unknown | China | Herelleviridae | Sewage | KY779848.1 |
| vB_SauH_IME522 | 140246 | 30.2 | 224 | 4 | Unknown | China | Herelleviridae | Sewage | MN304941.1 |
| vB_SauM_515A1 | 148511 | 30.2 | 234 | 4 | Unknown | Russian | Herelleviridae | Human | MN047438.1 |
| vBSP_A2 | 136528 | 30.4 | 208 | 4 | 2017 | China | Herelleviridae | Sewage | MK656892.1 |
| P108 | 140807 | 30.3 | 233 | 3 | Unknown | China | Herelleviridae | Unknown | NC_025426.1 |

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|------------------|--------|------|-----|---|---------|-------------------|----------------|---------|-------------|
| MCE_2014 | 141907 | 30.4 | 214 | 4 | Unknown | United Kingdom | Herelleviridae | Unknown | NC_025416.1 |
| vB_SauM_Remus | 134643 | 29.9 | 191 | 1 | Unknown | Belgium | Herelleviridae | Unknown | NC_022090.1 |
| GH15 | 139806 | 30.3 | 216 | 4 | Unknown | China | Herelleviridae | Unknown | NC_019448.1 |
| vBSM_A1 | 140654 | 30.3 | 217 | 4 | 2017 | China | Herelleviridae | Sewage | MK584893.1 |
| CH1 | 138057 | 30.5 | 224 | 4 | Unknown | Russian | Herelleviridae | Unknown | MK331930.1 |
| 812h1 | 150582 | 30.4 | 243 | 4 | 2016 | Czech Republic | Herelleviridae | Unknown | MH844529.1 |
| HSA30 | 140358 | 30.2 | 224 | 4 | Unknown | Republic of Korea | Herelleviridae | Unknown | MG557618.1 |
| HYZ21 | 139675 | 30.4 | 218 | 4 | 2016 | China | Herelleviridae | Human | MH136584.1 |
| vB_SauM_Romulus | 131332 | 30.0 | 182 | 1 | Unknown | United State | Herelleviridae | Unknown | NC_020877.1 |
| vB_SauM_0414_108 | 151627 | 30.4 | 247 | 4 | Unknown | United State | Herelleviridae | Unknown | MH107769.1 |
| phiSA_BS2 | 149229 | 29.7 | 227 | 1 | Unknown | China | Herelleviridae | Bovine | MH028956.1 |
| phiSA_BS1 | 142978 | 29.8 | 216 | 1 | Unknown | China | Herelleviridae | Bovine | MH078572.1 |
| vB_Sau_S24 | 139997 | 30.8 | 210 | 2 | Unknown | Argentina | Herelleviridae | Unknown | KY794643.1 |
| vB_Sau_Clo6 | 143734 | 30.8 | 215 | 1 | Unknown | Argentina | Herelleviridae | Unknown | KY794642.1 |
| vB_Sau_CG | 142934 | 30.5 | 222 | 5 | Unknown | Argentina | Herelleviridae | Unknown | KY794641.1 |
| pSa_3 | 137836 | 30.4 | 212 | 4 | 2016 | South Korea | Herelleviridae | Unknown | KY581279.1 |
| IME_SA119 | 141028 | 30.3 | 220 | 4 | Unknown | China | Herelleviridae | Sewage | KR908644.1 |
| IME_SA118 | 139750 | 30.3 | 215 | 4 | 2014 | China | Herelleviridae | Sewage | KR902361.1 |
| IME_SA2 | 140906 | 30.3 | 226 | 4 | Unknown | China | Herelleviridae | Sewage | KP687432.1 |
| IME_SA1 | 140218 | 30.3 | 223 | 4 | Unknown | China | Herelleviridae | Sewage | KP687431.1 |
| SA5 | 137031 | 30.5 | 224 | 4 | Unknown | United State | Herelleviridae | Unknown | JX875065.1 |
| ISP | 138339 | 30.5 | 213 | 4 | Unknown | Georgia | Herelleviridae | Unknown | FR852584.1 |
| Twort | 130706 | 30.2 | 179 | 1 | Unknown | Canada | Herelleviridae | Unknown | NC_007021.1 |
| G1 | 138715 | 30.4 | 213 | 4 | Unknown | Canada | Herelleviridae | Unknown | NC_007066.1 |
| SapYZU15 | 135178 | 29.8 | 187 | 0 | 2020 | China | Herelleviridae | Sewage | MW864252 |

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|-------------------------|-------|------|----|---|---------|--------------|-------------|--------------------|-------------|
| SapYZU11 | 17790 | 28.8 | 22 | 0 | 2020 | China | Podoviridae | Sewage | MW864250 |
| Portland | 17711 | 29.3 | 18 | 0 | 2015 | United State | Podoviridae | Environmental swab | MN098325.1 |
| SA46_CTH2 | 17505 | 28.8 | 19 | 0 | 2017 | Japan | Podoviridae | Chicken | MK764384.1 |
| vB_SauP_436A1 | 18028 | 29.3 | 21 | 0 | 2019 | Russia | Podoviridae | Human | MN150710.1 |
| GRCS | 17869 | 28.9 | 20 | 0 | Unknown | India | Podoviridae | Unknown | NC_023550.1 |
| SAP_2 | 17938 | 29.0 | 21 | 0 | Unknown | South Korea | Podoviridae | Sewage | NC_009875.1 |
| CSA13 | 17034 | 28.9 | 18 | 0 | 2017 | South Korea | Podoviridae | Swine | MH107118.1 |
| Pabna | 17700 | 29.4 | 21 | 0 | 2015 | United State | Podoviridae | Sewage | MH972260.1 |
| BP39 | 17641 | 29.1 | 21 | 0 | 2002 | Canada | Podoviridae | Sewage | NC_031046.1 |
| SLPW | 17861 | 29.3 | 20 | 0 | 2013 | China | Podoviridae | Unknown | NC_031008.1 |
| S24_1 | 18168 | 28.9 | 21 | 0 | Unknown | Japan | Podoviridae | Sewage | NC_016565.1 |
| 66 | 18199 | 29.2 | 21 | 0 | Unknown | United State | Podoviridae | Unknown | NC_007046.1 |
| phiP68 | 18227 | 29.3 | 19 | 0 | Unknown | United State | Podoviridae | Unknown | NC_004679.1 |
| vB_SauP_phiAGO1_9 | 17637 | 28.9 | 20 | 0 | Unknown | Poland | Podoviridae | Unknown | MG766219.2 |
| vB_SauP_phiAGO1_3 | 17603 | 28.9 | 20 | 0 | Unknown | Poland | Podoviridae | Unknown | MG766218.1 |
| SCH111 | 18018 | 29.3 | 22 | 0 | Unknown | Russian | Podoviridae | Unknown | KY000085.1 |
| SCH1 | 18023 | 29.3 | 21 | 0 | Unknown | Russian | Podoviridae | Unknown | KY000084.1 |
| PSa3 | 17602 | 29.6 | 18 | 0 | Unknown | Germany | Podoviridae | Unknown | HF937074.1 |
| S13 | 18186 | 29.2 | 21 | 0 | Unknown | Japan | Podoviridae | Sewage | AB626963.1 |
| 44AHJD | 16784 | 29.6 | 18 | 0 | Unknown | Austria | Podoviridae | Unknown | NC_004678.1 |
| Outgroup | | | | | | | | | |
| Erwinia_phage_phiEa2809 | | | | | | | | | NC_027340.1 |

Table S2. Orthogroup clusters of the lineage I, clade IIa – clade IIc, clade IIIa- IIIe phages.

| ORFs | Protein(aa) | Putative function | Best phage homolog | Identity(%) | Accession no. |
|------------------------|-------------|--|--------------------|-------------|---------------|
| Lineage I, n=20 | | | | | |
| OG0000000 | 160 | hypothetical protein | SapYZU11 | 100 | MW864250 |
| OG0000001 | 120 | hypothetical protein | SapYZU11 | 100 | MW864250 |
| OG0000002 | 61 | hypothetical protein | SapYZU11 | 100 | MW864250 |
| OG0000003 | 409 | major head protein | SapYZU11 | 100 | MW864250 |
| OG0000004 | 328 | upper collar protein | SapYZU11 | 100 | MW864250 |
| OG0000005 | 252 | lower collar protein | SapYZU11 | 100 | MW864250 |
| OG0000006 | 648 | minor structural protein | SapYZU11 | 100 | MW864250 |
| OG0000007 | 251 | lysin | SapYZU11 | 100 | MW864250 |
| OG0000009 | 588 | tail fiber protein | SapYZU11 | 100 | MW864250 |
| OG0000010 | 140 | holin | SapYZU11 | 100 | MW864250 |
| OG0000011 | 480 | lysin | SapYZU11 | 100 | MW864250 |
| OG0000012 | 762 | DNA polymerase | SapYZU11 | 100 | MW864250 |
| OG0000013 | 416 | DNA packaging protein | SapYZU11 | 100 | MW864250 |
| OG0000014 | 123 | single-stranded DNA binding protein | SapYZU11 | 100 | MW864250 |
| OG0000015 | 79 | hypothetical protein | SapYZU11 | 100 | MW864250 |
| OG0000016 | 101 | hypothetical protein | SapYZU11 | 100 | MW864250 |
| Clade IIa, n=8 | | | | | |
| OG0000000 | 307 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000001 | 369 | putative transposase | SapYZU15 | 100 | MW864252 |
| OG0000002 | 146 | pentapeptide repeat-containing protein | SapYZU15 | 100 | MW864252 |
| OG0000003 | 171 | structural protein | SapYZU15 | 100 | MW864252 |
| OG0000004 | 190 | phage lysin | SapYZU15 | 100 | MW864252 |
| OG0000005 | 90 | DNA methylase | SapYZU15 | 100 | MW864252 |
| OG0000006 | 239 | HNH endonuclease family protein | SapYZU15 | 100 | MW864252 |
| OG0000008 | 179 | terL | SapYZU15 | 100 | MW864252 |
| OG0000009 | 1250 | putative DNA polymerase I | SapYZU15 | 100 | MW864252 |
| OG0000011 | 189 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000012 | 578 | DNA synthesis | SapYZU15 | 100 | MW864252 |
| OG0000013 | 161 | homing endonuclease | SapYZU15 | 100 | MW864252 |
| OG0000014 | 109 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000015 | 107 | thioredoxin-like protein | SapYZU15 | 100 | MW864252 |
| OG0000016 | 201 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000017 | 101 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000018 | 161 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000019 | 368 | hypothetical protein | SapYZU15 | 100 | MW864252 |

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|-----------|-----|---------------------------------|----------|-----|----------|
| OG0000020 | 75 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000021 | 323 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000022 | 309 | putative DNA repair recombinase | SapYZU15 | 100 | MW864252 |
| OG0000023 | 118 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000024 | 220 | sigma factor | SapYZU15 | 100 | MW864252 |
| OG0000025 | 211 | structural protein | SapYZU15 | 100 | MW864252 |
| OG0000026 | 85 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000027 | 257 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000028 | 418 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000029 | 110 | putative membrane protein | SapYZU15 | 100 | MW864252 |
| OG0000030 | 178 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000031 | 254 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000032 | 169 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000033 | 285 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000034 | 244 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000035 | 153 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000036 | 146 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000037 | 212 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000038 | 133 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000039 | 84 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000040 | 88 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000041 | 95 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000042 | 98 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000043 | 105 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000044 | 82 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000045 | 166 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000046 | 184 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000047 | 69 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000048 | 86 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000049 | 105 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000050 | 94 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000051 | 85 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000052 | 105 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000053 | 227 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000054 | 80 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000055 | 117 | YopX protein | SapYZU15 | 100 | MW864252 |
| OG0000056 | 66 | phage protein | SapYZU15 | 100 | MW864252 |
| OG0000057 | 180 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000058 | 262 | DNA-binding protein | SapYZU15 | 100 | MW864252 |
| OG0000059 | 121 | nuclease | SapYZU15 | 100 | MW864252 |

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|-----------|-----|--------------------------------|----------|-----|----------|
| OG0000060 | 108 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000061 | 139 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000062 | 68 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000063 | 54 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000064 | 681 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000065 | 88 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000066 | 58 | LysM domain-containing protein | SapYZU15 | 100 | MW864252 |
| OG0000067 | 208 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000068 | 198 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000069 | 88 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000070 | 142 | ribonuclease H | SapYZU15 | 100 | MW864252 |
| OG0000071 | 63 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000072 | 213 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000073 | 72 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000074 | 74 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000076 | 167 | holin | SapYZU15 | 100 | MW864252 |
| OG0000077 | 63 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000078 | 72 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000079 | 72 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000080 | 111 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000081 | 111 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000082 | 129 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000083 | 94 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000084 | 138 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000085 | 80 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000086 | 267 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000087 | 58 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000088 | 160 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000089 | 250 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000090 | 120 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000091 | 122 | putative portal protein | SapYZU15 | 100 | MW864252 |
| OG0000092 | 294 | putative portal protein | SapYZU15 | 100 | MW864252 |
| OG0000093 | 255 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000094 | 312 | Microtubule-associated protein | SapYZU15 | 100 | MW864252 |
| OG0000095 | 464 | major capsid protein | SapYZU15 | 100 | MW864252 |
| OG0000096 | 78 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000097 | 250 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000098 | 292 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000099 | 207 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000100 | 279 | hypothetical protein | SapYZU15 | 100 | MW864252 |

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|-----------|------|---|----------|-----|----------|
| OG0000101 | 69 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000102 | 587 | tail sheath protein | SapYZU15 | 100 | MW864252 |
| OG0000103 | 123 | capsid protein | SapYZU15 | 100 | MW864252 |
| OG0000104 | 46 | major capsid protein | SapYZU15 | 100 | MW864252 |
| OG0000105 | 150 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000106 | 103 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000107 | 149 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000108 | 153 | RNA polymerase | SapYZU15 | 100 | MW864252 |
| OG0000109 | 988 | tail lysin | SapYZU15 | 100 | MW864252 |
| OG0000110 | 290 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000111 | 275 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000112 | 733 | tail lysin | SapYZU15 | 100 | MW864252 |
| OG0000113 | 298 | tail lysin | SapYZU15 | 100 | MW864252 |
| OG0000114 | 819 | glycerophosphoryl diester phosphodiesterase | SapYZU15 | 100 | MW864252 |
| OG0000115 | 284 | structural protein | SapYZU15 | 100 | MW864252 |
| OG0000116 | 174 | structural protein | SapYZU15 | 100 | MW864252 |
| OG0000117 | 235 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000118 | 349 | baseplate J-like protein | SapYZU15 | 100 | MW864252 |
| OG0000119 | 901 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000120 | 174 | structural protein | SapYZU15 | 100 | MW864252 |
| OG0000121 | 1153 | virulence-associated protein | SapYZU15 | 100 | MW864252 |
| OG0000122 | 57 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000123 | 638 | structural protein | SapYZU15 | 100 | MW864252 |
| OG0000124 | 119 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000125 | 455 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000126 | 152 | DNA helicase | SapYZU15 | 100 | MW864252 |
| OG0000127 | 438 | Type III restriction enzyme | SapYZU15 | 100 | MW864252 |
| OG0000128 | 529 | Rep protein | SapYZU15 | 100 | MW864252 |
| OG0000129 | 480 | helicase/primase | SapYZU15 | 100 | MW864252 |
| OG0000130 | 82 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000131 | 344 | DNA repair exonuclease | SapYZU15 | 100 | MW864252 |
| OG0000132 | 89 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000133 | 493 | exonuclease | SapYZU15 | 100 | MW864252 |
| OG0000134 | 198 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000135 | 359 | DNA primase | SapYZU15 | 100 | MW864252 |
| OG0000136 | 103 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000137 | 146 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000138 | 203 | hypothetical protein | SapYZU15 | 100 | MW864252 |
| OG0000139 | 446 | reductase | SapYZU15 | 100 | MW864252 |

Clade IIb, n=2

| | | | | | |
|-----------|------|---|-----------|-----|----------|
| OG0000000 | 172 | major tail protein | phiSA_BS2 | 100 | MH028956 |
| OG0000001 | 245 | nucleotide metabolism it produces dUMP | phiSA_BS2 | 100 | MH028956 |
| OG0000002 | 326 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000003 | 157 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000004 | 91 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000005 | 82 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000006 | 176 | HNH homing endonuclease | phiSA_BS2 | 100 | MH028956 |
| OG0000007 | 135 | YopX protein | phiSA_BS2 | 100 | MH028956 |
| OG0000008 | 62 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000009 | 240 | LysM | phiSA_BS2 | 100 | MH028956 |
| OG0000010 | 145 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000011 | 263 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000012 | 336 | midasin | phiSA_BS2 | 100 | MH028956 |
| OG0000013 | 475 | major capsid protein | phiSA_BS2 | 100 | MH028956 |
| OG0000014 | 94 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000015 | 304 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000016 | 294 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000017 | 203 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000018 | 281 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000019 | 72 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000020 | 590 | major tail sheath | phiSA_BS2 | 100 | MH028956 |
| OG0000021 | 131 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000022 | 184 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000023 | 210 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000024 | 1407 | Phage tail tape measure protein | phiSA_BS2 | 100 | MH028956 |
| OG0000025 | 812 | secretory antigen SsaA-like protein | phiSA_BS2 | 100 | MH028956 |
| OG0000026 | 301 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000027 | 969 | glycerophosphoryl diester phosphodiesterase | phiSA_BS2 | 100 | MH028956 |
| OG0000028 | 368 | extracellular serine protease | phiSA_BS2 | 100 | MH028956 |
| OG0000029 | 157 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000030 | 267 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000031 | 176 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000032 | 233 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000033 | 349 | Baseplate J-like protein | phiSA_BS2 | 100 | MH028956 |
| OG0000034 | 892 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000035 | 173 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000036 | 1160 | virulence-associated protein | phiSA_BS2 | 100 | MH028956 |
| OG0000037 | 57 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000038 | 660 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000039 | 136 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |

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|-----------|-----|---|-----------|-----|----------|
| OG0000040 | 466 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000041 | 587 | Type III restriction enzyme, DNA helicase | phiSA_BS2 | 100 | MH028956 |
| OG0000042 | 515 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000043 | 482 | DNA helicase | phiSA_BS2 | 100 | MH028956 |
| OG0000044 | 91 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000045 | 113 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000046 | 94 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000047 | 343 | Exonuclease SbcD, recombination exonuclease | phiSA_BS2 | 100 | MH028956 |
| OG0000048 | 126 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000049 | 637 | recombination-related exonuclease | phiSA_BS2 | 100 | MH028956 |
| OG0000050 | 213 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000051 | 354 | DNA primase/helicase | phiSA_BS2 | 100 | MH028956 |
| OG0000052 | 105 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000053 | 132 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000054 | 203 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000055 | 131 | ribonucleotide reduction protein | phiSA_BS2 | 100 | MH028956 |
| OG0000056 | 705 | DNA synthesis | phiSA_BS2 | 100 | MH028956 |
| OG0000057 | 351 | DNA synthesis | phiSA_BS2 | 100 | MH028956 |
| OG0000058 | 113 | oxidoreductase | phiSA_BS2 | 100 | MH028956 |
| OG0000059 | 243 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000060 | 100 | integration host factor | phiSA_BS2 | 100 | MH028956 |
| OG0000061 | 91 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000062 | 820 | DNA polymerase I | phiSA_BS2 | 100 | MH028956 |
| OG0000063 | 242 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000064 | 219 | DNA polymerase I | phiSA_BS2 | 100 | MH028956 |
| OG0000065 | 171 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000066 | 43 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000067 | 78 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000068 | 45 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000069 | 74 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000070 | 60 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000071 | 222 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000072 | 198 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000073 | 161 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000074 | 134 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000075 | 412 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000076 | 74 | recombinase | phiSA_BS2 | 100 | MH028956 |
| OG0000077 | 323 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000078 | 315 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000079 | 121 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |

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|-----------|-----|---|-----------|-----|----------|
| OG0000080 | 218 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000081 | 217 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000082 | 84 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000083 | 125 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000084 | 70 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000085 | 130 | Src homology 3 domain superfamily protein | phiSA_BS2 | 100 | MH028956 |
| OG0000086 | 111 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000087 | 128 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000088 | 243 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000089 | 415 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000090 | 109 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000091 | 180 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000092 | 251 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000093 | 153 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000094 | 296 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000095 | 81 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000096 | 247 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000097 | 147 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000098 | 140 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000099 | 232 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000100 | 128 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000101 | 135 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000102 | 69 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000103 | 74 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000104 | 53 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000105 | 88 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000106 | 130 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000107 | 81 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000108 | 362 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000109 | 80 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000110 | 133 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000111 | 138 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000112 | 210 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000113 | 228 | DNA modification protein | phiSA_BS2 | 100 | MH028956 |
| OG0000114 | 81 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000115 | 61 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000116 | 57 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000117 | 34 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000118 | 35 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000119 | 133 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |

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|-----------|-----|--------------------------------------|-----------|-----|----------|
| OG0000120 | 35 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000121 | 98 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000122 | 61 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000123 | 308 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000124 | 305 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000125 | 100 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000126 | 33 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000127 | 72 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000128 | 90 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000129 | 85 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000130 | 51 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000131 | 49 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000132 | 92 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000133 | 84 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000134 | 129 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000135 | 65 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000136 | 72 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000137 | 120 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000138 | 158 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000139 | 30 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000140 | 74 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000141 | 170 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000142 | 83 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000143 | 165 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000144 | 151 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000145 | 123 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000146 | 236 | serine threonine protein phosphatase | phiSA_BS2 | 100 | MH028956 |
| OG0000147 | 115 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000148 | 104 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000149 | 120 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000150 | 80 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000151 | 83 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000152 | 71 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000153 | 38 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000154 | 76 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000155 | 243 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000156 | 171 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000157 | 96 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000158 | 61 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000159 | 111 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |

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|-----------|-----|---|-----------|-----|----------|
| OG0000160 | 340 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000161 | 58 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000162 | 126 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000163 | 139 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000164 | 65 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000165 | 237 | HNH endonuclease | phiSA_BS2 | 100 | MH028956 |
| OG0000166 | 78 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000167 | 78 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000168 | 115 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000169 | 62 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000170 | 123 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000171 | 145 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000172 | 42 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000173 | 87 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000174 | 362 | RNase and PhoH-family ATPase domain protein | phiSA_BS2 | 100 | MH028956 |
| OG0000175 | 253 | PhoH family | phiSA_BS2 | 100 | MH028956 |
| OG0000176 | 49 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000177 | 137 | Ribonuclease | phiSA_BS2 | 100 | MH028956 |
| OG0000178 | 65 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000179 | 202 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000180 | 69 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000181 | 68 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000182 | 80 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000183 | 548 | Phage portal protein | phiSA_BS2 | 100 | MH028956 |
| OG0000184 | 122 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000185 | 119 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000186 | 412 | ECM-binding protein homolog | phiSA_BS2 | 100 | MH028956 |
| OG0000187 | 117 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000188 | 166 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000189 | 44 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000190 | 389 | terminase large subunit | phiSA_BS2 | 100 | MH028956 |
| OG0000191 | 320 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000192 | 118 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000193 | 144 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000194 | 130 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000195 | 108 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000196 | 109 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000197 | 68 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000198 | 70 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |
| OG0000199 | 101 | hypothetical protein | phiSA_BS2 | 100 | MH028956 |

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|------------------------|------|--|-----------|-----|----------|
| OG0000200 | 185 | holin | phiSA_BS2 | 100 | MH028956 |
| OG0000201 | 129 | lysin | phiSA_BS2 | 100 | MH028956 |
| Clade IIc, n=46 | | | | | |
| OG0000000 | 210 | lysin | 676Z | 100 | JX080302 |
| OG0000019 | 1352 | tail morphogenetic protein C | 676Z | 100 | JX080302 |
| OG0000020 | 705 | DNA synthesis | 676Z | 100 | JX080302 |
| OG0000021 | 76 | tail morphogenetic protein I | 676Z | 100 | JX080302 |
| OG0000023 | 183 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000024 | 209 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000025 | 809 | tail murein hydrolase TAME | 676Z | 100 | JX080302 |
| OG0000026 | 1020 | tail morphogenetic protein F | 676Z | 100 | JX080302 |
| OG0000027 | 538 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000029 | 214 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000030 | 231 | putative transglycosylase | 676Z | 100 | JX080302 |
| OG0000031 | 606 | terminase large subunit | 676Z | 100 | JX080302 |
| OG0000032 | 258 | prohead protease | 676Z | 100 | JX080302 |
| OG0000033 | 296 | tail morphogenetic protein E | 676Z | 100 | JX080302 |
| OG0000034 | 175 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000035 | 583 | Type III restriction enzyme, res subunit | 676Z | 100 | JX080302 |
| OG0000036 | 252 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000037 | 144 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000038 | 236 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000039 | 161 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000040 | 109 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000041 | 139 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000042 | 88 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000043 | 58 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000044 | 193 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000045 | 247 | PhoH-like protein | 676Z | 100 | JX080302 |
| OG0000046 | 205 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000047 | 142 | putative ribonuclease | 676Z | 100 | JX080302 |
| OG0000048 | 64 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000049 | 77 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000050 | 168 | holin | 676Z | 100 | JX080302 |
| OG0000051 | 62 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000052 | 73 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000053 | 70 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000054 | 111 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000055 | 89 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000056 | 93 | hypothetical protein | 676Z | 100 | JX080302 |

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|-----------|------|---|------|-----|----------|
| OG0000057 | 137 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000058 | 274 | structural head protein | 676Z | 100 | JX080302 |
| OG0000059 | 160 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000060 | 398 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000061 | 117 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000062 | 124 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000063 | 564 | Phage portal protein | 676Z | 100 | JX080302 |
| OG0000064 | 317 | tail structural protein | 676Z | 100 | JX080302 |
| OG0000065 | 464 | major capsid protein | 676Z | 100 | JX080302 |
| OG0000066 | 99 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000067 | 303 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000068 | 293 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000069 | 207 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000070 | 279 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000071 | 72 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000072 | 588 | major tail sheath protein | 676Z | 100 | JX080302 |
| OG0000073 | 119 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000074 | 47 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000075 | 153 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000076 | 104 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000077 | 153 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000078 | 179 | tail morphogenetic protein B | 676Z | 100 | JX080302 |
| OG0000079 | 849 | glycerophosphoryl diester phosphodiesterase | 676Z | 100 | JX080302 |
| OG0000080 | 235 | putative baseplate wedge subunit | 676Z | 100 | JX080302 |
| OG0000081 | 349 | Baseplate J-like protein | 676Z | 100 | JX080302 |
| OG0000082 | 174 | baseplate morphogenetic protein C | 676Z | 100 | JX080302 |
| OG0000083 | 1153 | virulence-associated protein | 676Z | 100 | JX080302 |
| OG0000084 | 53 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000085 | 641 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000086 | 125 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000087 | 459 | structural baseplate protein | 676Z | 100 | JX080302 |
| OG0000088 | 468 | DNA helicase B | 676Z | 100 | JX080302 |
| OG0000089 | 346 | recombination nuclease B | 676Z | 100 | JX080302 |
| OG0000090 | 640 | recombination nuclease B | 676Z | 100 | JX080302 |
| OG0000091 | 199 | anti-sigma factor | 676Z | 100 | JX080302 |
| OG0000092 | 356 | DNA primase | 676Z | 100 | JX080302 |
| OG0000093 | 113 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000094 | 151 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000095 | 203 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000096 | 144 | ribonucleotide reductase | 676Z | 100 | JX080302 |

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|-------------------------|------|-------------------------------------|------|-----|-----------|
| OG0000097 | 350 | DNA synthesis | 676Z | 100 | JX080302 |
| OG0000098 | 107 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000099 | 199 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000100 | 102 | transcription factor | 676Z | 100 | JX080302 |
| OG0000101 | 161 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000102 | 424 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000103 | 419 | putative repair recombinase to RecA | 676Z | 100 | JX080302 |
| OG0000104 | 118 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000105 | 221 | putative RNA polymerase | 676Z | 100 | JX080302 |
| OG0000106 | 211 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000107 | 87 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000108 | 417 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000109 | 179 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000110 | 256 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000111 | 149 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000112 | 244 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000113 | 153 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000114 | 148 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000115 | 235 | hypothetical protein | 676Z | 100 | JX080302 |
| OG0000116 | 133 | hypothetical protein | 676Z | 100 | JX080302 |
| Clade IIIa, n=29 | | | | | |
| OG0000001 | 55 | | 3A | 100 | NC_007053 |
| OG0000003 | 456 | DEAD/DEAH box helicase | 3A | 100 | NC_007053 |
| OG0000004 | 108 | terminase small subunit | 3A | 100 | NC_007053 |
| OG0000005 | 564 | Terminase, large subunit | 3A | 100 | NC_007053 |
| OG0000006 | 413 | portal protein | 3A | 100 | NC_007053 |
| OG0000007 | 256 | ATP-dependent Clp protease | 3A | 100 | NC_007053 |
| OG0000008 | 403 | major capsid protein | 3A | 100 | NC_007053 |
| OG0000009 | 93 | head-tail connector protein | 3A | 100 | NC_007053 |
| OG0000010 | 111 | hypothetical protein | 3A | 100 | NC_007053 |
| OG0000011 | 134 | hypothetical protein | 3A | 100 | NC_007053 |
| OG0000012 | 132 | hypothetical protein | 3A | 100 | NC_007053 |
| OG0000013 | 214 | tail protein | 3A | 100 | NC_007053 |
| OG0000014 | 152 | Phage tail tape measure protein | 3A | 100 | NC_007053 |
| OG0000015 | 117 | hypothetical protein | 3A | 100 | NC_007053 |
| OG0000016 | 53 | hypothetical protein | 3A | 100 | NC_007053 |
| OG0000017 | 1658 | tail tape measure protein | 3A | 100 | NC_007053 |
| OG0000018 | 275 | Phage tail protein | 3A | 100 | NC_007053 |
| OG0000019 | 528 | tail protein | 3A | 100 | NC_007053 |
| OG0000020 | 97 | hypothetical protein | 3A | 100 | NC_007053 |

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|-------------------------|------|--------------------------------------|-----------|-----|-----------|
| OG0000021 | 637 | Teichoic acid biosynthesis protein C | 3A | 100 | NC_007053 |
| OG0000023 | 104 | hypothetical protein | 3A | 100 | NC_007053 |
| OG0000024 | 116 | holin | 3A | 100 | NC_007053 |
| OG0000025 | 485 | lysin | 3A | 100 | NC_007053 |
| OG0000026 | 62 | hypothetical protein | 3A | 100 | NC_007053 |
| OG0000027 | 135 | PVL family protein | 3A | 100 | NC_007053 |
| OG0000028 | 51 | hypothetical protein | 3A | 100 | NC_007053 |
| OG0000029 | 78 | hypothetical protein | 3A | 100 | NC_007053 |
| Clade IIIb, n=16 | | | | | |
| OG0000000 | 1262 | Minor structural protein | 23MRA | 100 | NC_028775 |
| OG0000001 | 708 | Tape measure protein | 23MRA | 100 | NC_028775 |
| OG0000002 | 396 | Phage portal protein | 23MRA | 100 | NC_028775 |
| OG0000003 | 93 | HNH endonuclease | 23MRA | 100 | NC_028775 |
| OG0000004 | 139 | transcriptional | 23MRA | 100 | NC_028775 |
| OG0000005 | 81 | PVL | 23MRA | 100 | NC_028775 |
| OG0000006 | 126 | hypothetical protein | 23MRA | 100 | NC_028775 |
| OG0000007 | 87 | hypothetical protein | 23MRA | 100 | NC_028775 |
| OG0000009 | 238 | hypothetical protein | 23MRA | 100 | NC_028775 |
| OG0000010 | 96 | hypothetical protein | 23MRA | 100 | NC_028775 |
| OG0000011 | 51 | hypothetical protein | 23MRA | 100 | NC_028775 |
| OG0000012 | 495 | Phage tail protein | 23MRA | 100 | NC_028775 |
| OG0000013 | 117 | hypothetical protein | 23MRA | 100 | NC_028775 |
| OG0000014 | 215 | Major tail protein | 23MRA | 100 | NC_028775 |
| OG0000015 | 135 | hypothetical protein | 23MRA | 100 | NC_028775 |
| OG0000016 | 135 | hypothetical protein | 23MRA | 100 | NC_028775 |
| OG0000017 | 121 | head-tail adaptor protein | 23MRA | 100 | NC_028775 |
| OG0000018 | 99 | head-tail adapter protein | 23MRA | 100 | NC_028775 |
| OG0000019 | 87 | hypothetical protein | 23MRA | 100 | NC_028775 |
| OG0000020 | 382 | major capsid protein | 23MRA | 100 | NC_028775 |
| OG0000021 | 248 | ATP-dependent Clp protease | 23MRA | 100 | NC_028775 |
| OG0000022 | 554 | Terminase, large subunit | 23MRA | 100 | NC_028775 |
| OG0000023 | 134 | hypothetical protein | 23MRA | 100 | NC_028775 |
| Clade IIIc, n=11 | | | | | |
| OG0000000 | 1551 | Tape measure protein | 3_AJ_2017 | 100 | KX232515 |
| OG0000001 | 1262 | Minor structural protein | 3_AJ_2017 | 100 | KX232515 |
| OG0000002 | 497 | tail length tape-measure protein | 3_AJ_2017 | 100 | KX232515 |
| OG0000003 | 126 | hypothetical protein | 3_AJ_2017 | 100 | KX232515 |
| OG0000004 | 96 | hypothetical protein | 3_AJ_2017 | 100 | KX232515 |
| OG0000005 | 149 | hypothetical protein | 3_AJ_2017 | 100 | KX232515 |
| OG0000006 | 318 | hypothetical protein | 3_AJ_2017 | 100 | KX232515 |

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|--------------------------|-----|--|-----------|-----|-----------|
| OG0000007 | 127 | hypothetical protein | 3_AJ_2017 | 100 | KX232515 |
| OG0000008 | 112 | hypothetical protein | 3_AJ_2017 | 100 | KX232515 |
| OG0000009 | 53 | hypothetical protein | 3_AJ_2017 | 100 | KX232515 |
| OG0000010 | 416 | capsid protein | 3_AJ_2017 | 100 | KX232515 |
| OG0000011 | 195 | Prohead protease | 3_AJ_2017 | 100 | KX232515 |
| OG0000012 | 417 | portal protein | 3_AJ_2017 | 100 | KX232515 |
| OG0000013 | 80 | hypothetical protein | 3_AJ_2017 | 100 | KX232515 |
| OG0000014 | 565 | Terminase, large subunit | 3_AJ_2017 | 100 | KX232515 |
| OG0000015 | 156 | phage terminase small subunit | 3_AJ_2017 | 100 | KX232515 |
| OG0000016 | 115 | HNH endonuclease | 3_AJ_2017 | 100 | KX232515 |
| OG0000017 | 151 | Mazg nucleotide pyrophosphohydrolase | 3_AJ_2017 | 100 | KX232515 |
| OG0000018 | 173 | Bacterial regulatory proteins, luxR family | 3_AJ_2017 | 100 | KX232515 |
| OG0000019 | 67 | hypothetical protein | 3_AJ_2017 | 100 | KX232515 |
| OG0000020 | 50 | hypothetical protein | 3_AJ_2017 | 100 | KX232515 |
| OG0000021 | 69 | hypothetical protein | 3_AJ_2017 | 100 | KX232515 |
| OG0000022 | 82 | hypothetical protein | 3_AJ_2017 | 100 | KX232515 |
| OG0000023 | 81 | hypothetical protein | 3_AJ_2017 | 100 | KX232515 |
| OG0000024 | 115 | hypothetical protein | 3_AJ_2017 | 100 | KX232515 |
| OG0000025 | 157 | single-stranded DNA-binding protein | 3_AJ_2017 | 100 | KX232515 |
| OG0000026 | 87 | hypothetical protein | 3_AJ_2017 | 100 | KX232515 |
| Clade IIIId, n=22 | | | | | |
| OG0000000 | 391 | baseplate upper protein | 11 | 100 | NC_004615 |
| OG0000001 | 482 | lysin | 11 | 100 | NC_004615 |
| OG0000002 | 87 | hypothetical protein | 11 | 100 | NC_004615 |
| OG0000003 | 120 | hypothetical protein | 11 | 100 | NC_004615 |
| OG0000004 | 83 | hypothetical protein | 11 | 100 | NC_004615 |
| OG0000005 | 85 | hypothetical protein | 11 | 100 | NC_004615 |
| OG0000006 | 63 | hypothetical protein | 11 | 100 | NC_004615 |
| OG0000007 | 141 | RinA family transcriptional activator | 11 | 100 | NC_004615 |
| OG0000008 | 151 | terminase small Subunit | 11 | 100 | NC_004615 |
| OG0000009 | 426 | Phage terminase, large subunit | 11 | 100 | NC_004615 |
| OG0000010 | 512 | portal protein | 11 | 100 | NC_004615 |
| OG0000011 | 332 | minor capsid protein | 11 | 100 | NC_004615 |
| OG0000012 | 57 | hypothetical protein | 11 | 100 | NC_004615 |
| OG0000013 | 212 | hypothetical protein | 11 | 100 | NC_004615 |
| OG0000014 | 325 | head protein | 11 | 100 | NC_004615 |
| OG0000015 | 96 | hypothetical protein | 11 | 100 | NC_004615 |
| OG0000016 | 111 | head-tail connector protein | 11 | 100 | NC_004615 |
| OG0000017 | 101 | hypothetical protein | 11 | 100 | NC_004615 |
| OG0000018 | 116 | hypothetical protein | 11 | 100 | NC_004615 |

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|-------------------------|------|--------------------------------------|----|-----|-----------|
| OG0000019 | 128 | hypothetical protein | 11 | 100 | NC_004615 |
| OG0000020 | 194 | tail protein | 11 | 100 | NC_004615 |
| OG0000021 | 122 | tail assembly chaperone | 11 | 100 | NC_004615 |
| OG0000022 | 115 | hypothetical protein | 11 | 100 | NC_004615 |
| OG0000023 | 1156 | hypothetical protein | 11 | 100 | NC_004615 |
| OG0000024 | 316 | tail family protein | 11 | 100 | NC_004615 |
| OG0000025 | 634 | tail protein | 11 | 100 | NC_004615 |
| OG0000026 | 637 | minor structural protein | 11 | 100 | NC_004615 |
| OG0000027 | 608 | hypothetical protein | 11 | 100 | NC_004615 |
| OG0000028 | 126 | hypothetical protein | 11 | 100 | NC_004615 |
| OG0000029 | 58 | hypothetical protein | 11 | 100 | NC_004615 |
| OG0000030 | 104 | hypothetical protein | 11 | 100 | NC_004615 |
| OG0000031 | 633 | lysin | 11 | 100 | NC_004615 |
| Clade IIIe, n=28 | | | | | |
| OG0000000 | 86 | hypothetical protein | 29 | 100 | NC_007061 |
| OG0000001 | 493 | Portal protein | 29 | 100 | NC_007061 |
| OG0000002 | 321 | minor head protein | 29 | 100 | NC_007061 |
| OG0000003 | 105 | head-tail connector protein | 29 | 100 | NC_007061 |
| OG0000004 | 112 | head closure protein | 29 | 100 | NC_007061 |
| OG0000005 | 138 | hypothetical protein | 29 | 100 | NC_007061 |
| OG0000006 | 146 | hypothetical protein | 29 | 100 | NC_007061 |
| OG0000007 | 187 | hypothetical protein | 29 | 100 | NC_007061 |
| OG0000008 | 165 | hypothetical protein | 29 | 100 | NC_007061 |
| OG0000009 | 106 | hypothetical protein | 29 | 100 | NC_007061 |
| OG0000010 | 1048 | terminase | 29 | 100 | NC_007061 |
| OG0000011 | 312 | tail family protein | 29 | 100 | NC_007061 |
| OG0000012 | 629 | tail protein | 29 | 100 | NC_007061 |
| OG0000013 | 633 | Teichoic acid biosynthesis protein C | 29 | 100 | NC_007061 |
| OG0000014 | 608 | hypothetical protein | 29 | 100 | NC_007061 |
| OG0000015 | 126 | hypothetical protein | 29 | 100 | NC_007061 |
| OG0000016 | 61 | hypothetical protein | 29 | 100 | NC_007061 |
| OG0000017 | 104 | hypothetical protein | 29 | 100 | NC_007061 |
| OG0000018 | 625 | lysin | 29 | 100 | NC_007061 |
| OG0000020 | 99 | hypothetical protein | 29 | 100 | NC_007061 |
| OG0000021 | 124 | hypothetical protein | 29 | 100 | NC_007061 |
| OG0000022 | 83 | hypothetical protein | 29 | 100 | NC_007061 |
| OG0000023 | 59 | transcriptional activator RinB | 29 | 100 | NC_007061 |