

1 **Title: Comparative genomics and functional analysis of the 936 group of lactococcal**
2 ***Siphoviridae* phages**

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31 **Figure S1. Amino acid sequence alignment of the TpeX homologs in the 936 group**
32 **phages.** Differences in amino acid sequences in comparison to PhiC0139 are shaded black.
33 Potential amino acids involved in carbohydrate binding as determined by HHPRED are
34 highlighted in the red boxes.

35 **Figure S2.** Dotplot analysis of a selection of 936 group phages. Sites were loss of synteny
36 correlate with sites of gene arrangements are highlighted by black arrows. **A)** 340 vs 645. **B)**
37 P008 vs PhiA.16. **C)** ASCC532 vs P008. **D)** PhiM.16 vs ASCC532. **E)** Phi19.2 vs PhiM.16
38 and **F)** Phi19.2 vs Phi5.12

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57 **Figure S1**

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10 20 30 40 50 60 70 80
PhiC0139_1 PSVDPGAHVAFAYSADGRDRFTTVWPNLNLLDGTDRDFS --- GPWENAGIWNVNDG --- TYKGLTVKSYQGTW
PhiB1127_1 PSVDPGAHVAFAYSADGRDRFTTVWPNLNLLDGTDRDFS --- GPWENAGIWNVNDG --- TYKGLTVKSYQGTW
Phi17_14 PEFPADEALMTAAAYSADGRDRFTTVWPNLNLLDGTDRDFS --- GPWENAGIWNVNDG --- TYKGLTVKSYQGTW
Phi5.12_13 PEFPADEALMTAAAYSADGRDRFTTVWPNLNLLDGTDRDFS --- GPWENAGIWNVNDG --- TYKGLTVKSYQGTW
Phi145_14 PEFPADEALMTAAAYSADGRDRFTTVWPNLNLLDGTDRDFS --- GPWENAGIWNVNDG --- TYKGLTVKSYQGTW
Phi91127_14 PEFPADEALMTAAAYSADGRDRFTTVWPNLNLLDGTDRDFS --- GPWENAGIWNVNDG --- TYKGLTVKSYQGTW
Phi16_15 PEFPADEALMTAAAYSADGRDRFTTVWPNLNLLDGTDRDFS --- GPWENAGIWNVNDG --- TYKGLTVKSYQGTW
Phi40_15 PEFPADEALMTAAAYSADGRDRFTTVWPNLNLLDGTDRDFS --- GPWENAGIWNVNDG --- TYKGLTVKSYQGTW
Phi93_16 PEFPADEALMTAAAYSADGRDRFTTVWPNLNLLDGTDRDFS --- GPWENAGIWNVNDG --- TYKGLTVKSYQGTW
PhiL.18_14 PEFPADEALMTAAAYSADGRDRFTTVWPNLNLLDGTDRDFS --- GPWENAGIWNVNDG --- TYKGLTVKSYQGTW
Phi109_15 PEFPADEALMTAAAYSADGRDRFTTVWPNLNLLDGTDRDFS --- GPWENAGIWNVNDG --- TYKGLTVKSYQGTW
PhiL.6_14 PEFPADEALMTAAAYSADGRDRFTTVWPNLNLLDGTDRDFS --- GPWENAGIWNVNDG --- TYKGLTVKSYQGTW
Phi4.2_13 PEFPADEALMTAAAYSADGRDRFTTVWPNLNLLDGTDRDFS --- GPWENAGIWNVNDG --- TYKGLTVKSYQGTW
PhiM1127_15 PEFPADEALMTAAAYSADGRDRFTTVWPNLNLLDGTDRDFS --- GPWENAGIWNVNDG --- TYKGLTVKSYQGTW
PhiM.5_14 PEFPADEALMTAAAYSADGRDRFTTVWPNLNLLDGTDRDFS --- GPWENAGIWNVNDG --- TYKGLTVKSYQGTW
P113G_0012 PSVDPGAHVAFAYSADGRDRFTTVWPNLNLLDGTDRDFS --- GPWENAGIWNVNDG --- TYKGLTVKSYQGTW
Phi7_gp13 PEFPADEALMTAAAYSADGRDRFTTVWPNLNLLDGTDRDFS --- GPWENAGIWNVNDG --- TYKGLTVKSYQGTW
P475_0013 PSVDPGAHVAFAYSADGRDRFTTVWPNLNLLDGTDRDFS --- GPWENAGIWNVNDG --- TYKGLTVKSYQGTW
712_12 PSVDPGAHVAFAYSADGRDRFTTVWPNLNLLDGTDRDFS --- GPWENAGIWNVNDG --- TYKGLTVKSYQGTW
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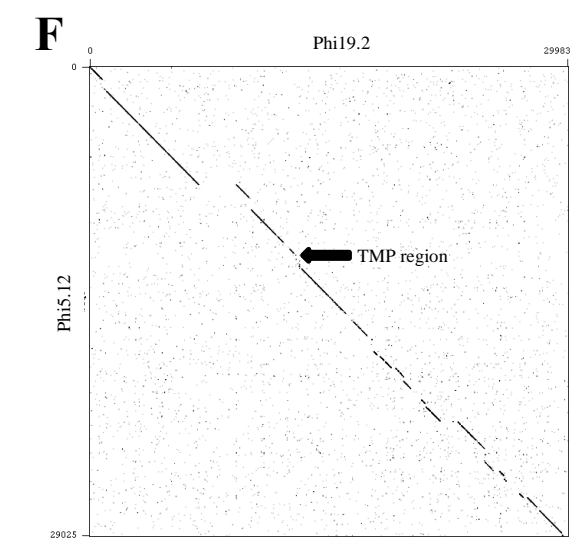
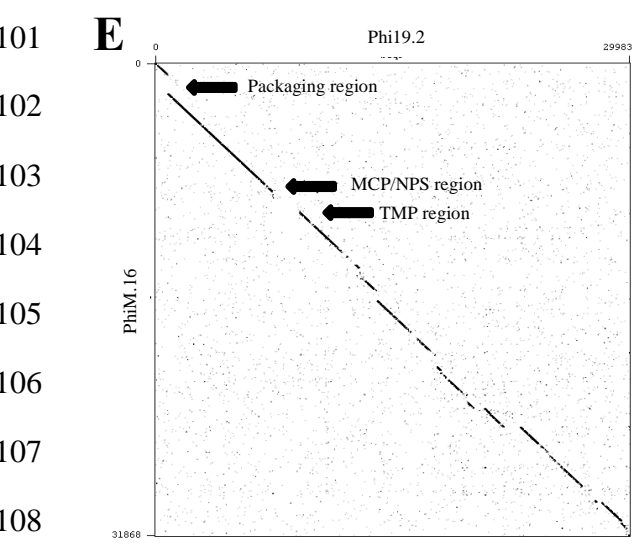
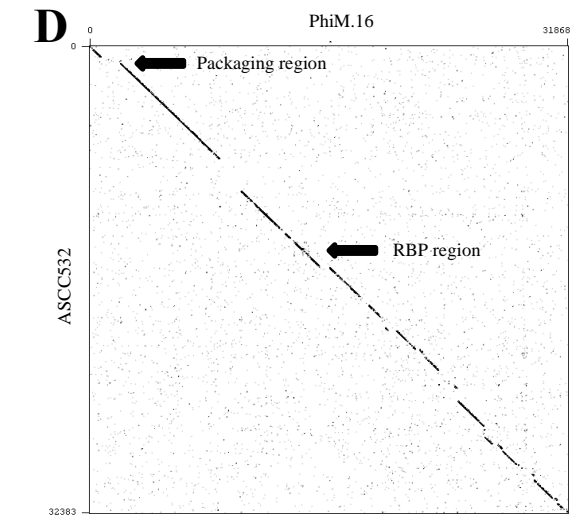
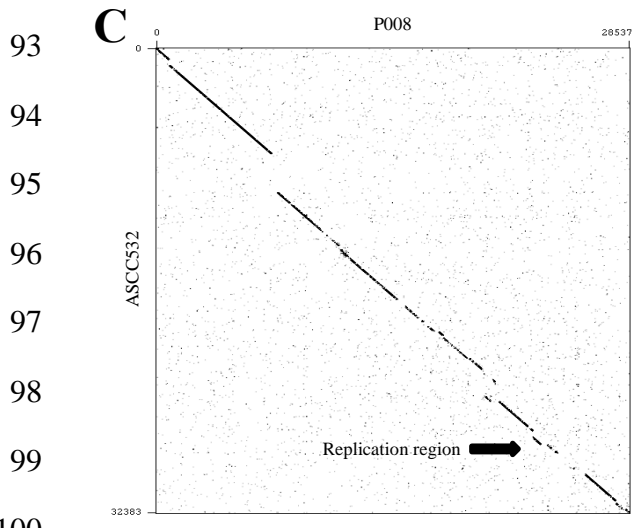
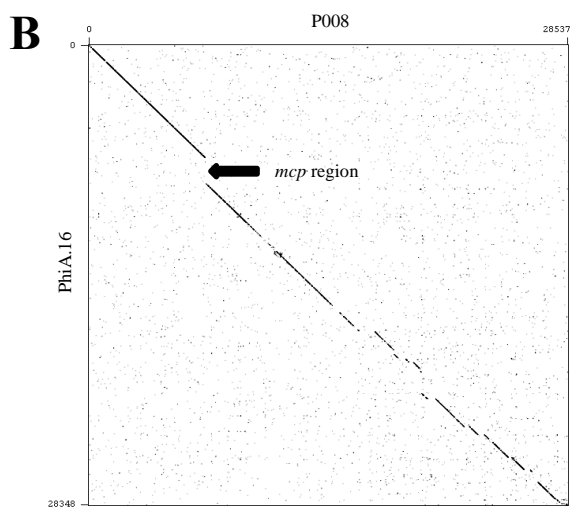
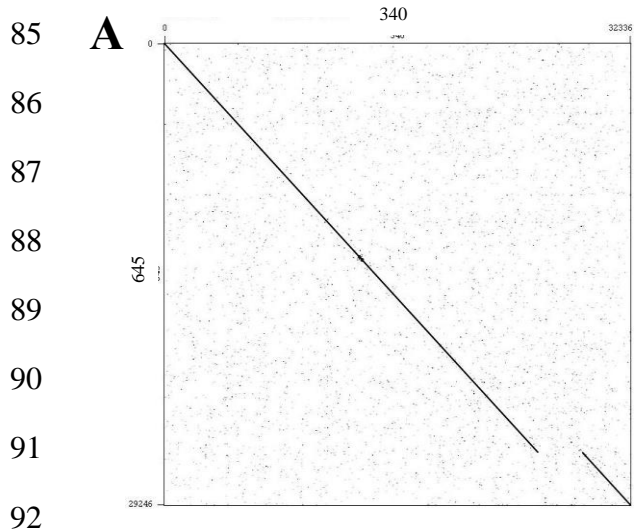
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PhiC0139_13 --- NGVFRKYL --- VPQDGLYTWSSFEVRSDS DTSNVRVLFINM --- VQKPNVGLGRKFDWLRDSVTVSLKKGDEV
PhiB1127_13 --- NGVFRKYL --- VPQDGLYTWSSFEVRSDS DTSNVRVLFINM --- VQKPNVGLGRKFDWLRDSVTVSLKKGDEV
Phi17_14 --- NAWWSINCEKNECDTIEVARVCSNCTGCGSWSSNEVRCMTAANDMETVEINNVYI
Phi5.12_13 --- NAWWSINCEKNECDTIEVARVCSNCTGCGSWSSNEVRCMTAANDMETVEINNVYI
Phi145_14 --- NAWWSINCEKNECDTIEVARVCSNCTGCGSWSSNEVRCMTAANDMETVEINNVYI
Phi91127_14 --- NAWWSINCEKNECDTIEVARVCSNCTGCGSWSSNEVRCMTAANDMETVEINNVYI
Phi16_15 --- NAWWSINCEKNECDTIEVARVCSNCTGCGSWSSNEVRCMTAANDMETVEINNVYI
Phi40_15 --- NAWWSINCEKNECDTIEVARVCSNCTGCGSWSSNEVRCMTAANDMETVEINNVYI
Phi93_16 --- NAWWSINCEKNECDTIEVARVCSNCTGCGSWSSNEVRCMTAANDMETVEINNVYI
PhiL.18_14 --- NAWWSINCEKNECDTIEVARVCSNCTGCGSWSSNEVRCMTAANDMETVEINNVYI
Phi109_15 --- NAWWSINCEKNECDTIEVARVCSNCTGCGSWSSNEVRCMTAANDMETVEINNVYI
PhiL.6_14 --- NAWWSINCEKNECDTIEVARVCSNCTGCGSWSSNEVRCMTAANDMETVEINNVYI
Phi4.2_13 FAFIRKFNELISSEFENVVKEENECYTESWIKETCHHITLAWNLWNEFNEQITLITLIGTWKYLITLWNSZAFATITTEEV
PhiM1127_15 --- NAWWSINCEKNECDTIEVARVCSNCTGCGSWSSNEVRCMTAANDMETVEINNVYI
PhiM.5_14 --- NAWWSINCEKNECDTIEVARVCSNCTGCGSWSSNEVRCMTAANDMETVEINNVYI
P113G_0012 --- CGGTSRTEET --- FPDGTYTSSAYVKSSCNNAETREVIIVLKGTSIVPKKRGHFDWLRDSSESLKLGKRV
Phi7_gp13 --- CGGTSRTEET --- FPDGTYTSSAYVKSSCNNAETREVIIVLKGTSIVPKKRGHFDWLRDSSESLKLGKRV
P475_0013 --- CGGTSRTEET --- FPDGTYTSSAYVKSSCNNAETREVIIVLKGTSIVPKKRGHFDWLRDSSESLKLGKRV
712_12 --- CGGTSRTEET --- FPDGTYTSSAYVKSSCNNAETREVIIVLKGTSIVPKKRGHFDWLRDSSESLKLGKRV
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170 180 190 200 210 220 230
PhiC0139_13 IFNYGNSEKN --- GGVSIAGYKLETGSIATPWPMPFSEVTPSDYPSYIGTYTDNDSSKQSTDPARYTWKKIVE
PhiB1127_13 IFNYGNSEKN --- GGVSIAGYKLETGSIATPWPMPFSEVTPSDYPSYIGTYTDNDSSKQSTDPARYTWKKIVE
Phi17_14 VASYSKSEHITITICGHNCKE KLE GSVTPWMSSESEIE SDYPSYIGNYTCRIVIE QSTDPRYRWKKIE
Phi5.12_13 VASYSKSEHITITICGHNCKE KLE GSVTPWMSSESEIE SDYPSYIGNYTCRIVIE QSTDPRYRWKKIE
Phi145_14 VASYSKSEHITITICGHNCKE KLE GSVTPWMSSESEIE SDYPSYIGNYTCRIVIE QSTDPRYRWKKIE
Phi91127_14 VASYSKSEHITITICGHNCKE KLE GSVTPWMSSESEIE SDYPSYIGNYTCRIVIE QSTDPRYRWKKIE
Phi16_15 VASYSKSEHITITICGHNCKE KLE GSVTPWMSSESEIE SDYPSYIGNYTCRIVIE QSTDPRYRWKKIE
Phi40_15 VASYSKSEHITITICGHNCKE KLE GSVTPWMSSESEIE SDYPSYIGNYTCRIVIE QSTDPRYRWKKIE
Phi93_16 VASYSKSEHITITICGHNCKE KLE GSVTPWMSSESEIE SDYPSYIGNYTCRIVIE QSTDPRYRWKKIE
PhiL.18_14 VASYSKSEHITITICGHNCKE KLE GSVTPWMSSESEIE SDYPSYIGNYTCRIVIE QSTDPRYRWKKIE
Phi109_15 VASYSKSEHITITICGHNCKE KLE GSVTPWMSSESEIE SDYPSYIGNYTCRIVIE QSTDPRYRWKKIE
PhiL.6_14 VASYSKSEHITITICGHNCKE KLE GSVTPWMSSESEIE SDYPSYIGNYTCRIVIE QSTDPRYRWKKIE
Phi4.2_13 GFHISEVMG --- SEINIKKEKVEGSIATPMPFSEVTPSDYPSYIGTYTDNDSSKQSTDPARYSWKIE
PhiM1127_15 VASYSKSEHITITICGHNCKE KLE GSVTPWMSSESEIE SDYPSYIGNYTCRIVIE QSTDPRYRWKKIE
PhiM.5_14 VASYSKSEHITITICGHNCKE KLE GSVTPWMSSESEIE SDYPSYIGNYTCRIVIE QSTDPRYRWKKIE
P113G_0012 SATYELTSCG --- SISIIWAGKVEGSIATPWPMPFSEVTPSDYPSYIGTYTDNDSSKQSTDPARYTWKKIE
Phi7_gp13 SATYELTSCG --- SISIIWAGKVEGSIATPWPMPFSEVTPSDYPSYIGTYTDNDSSKQSTDPARYTWKKIE
P475_0013 SATYELTSCG --- SISIIWAGKVEGSIATPWPMPFSEVTPSDYPSYIGTYTDNDSSKQSTDPARYTWKKIE
712_12 SATYELTSCG --- SISIIWAGKVEGSIATPWPMPFSEVTPSDYPSYIGTYTDNDSSKQSTDPARYTWKKIE
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84 **Figure S2**



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111 **Table S1.** Bacteria, plasmids, additional phages and primers used in this study.

Lactococcal subspecies	Strain (CWPS type)	Source
<i>ssp. lactis</i>	SM A (Unknown)	36
<i>ssp. cremoris</i>	SM B (A)	36
<i>ssp. cremoris</i>	SM C (A)	36
<i>ssp. cremoris</i>	SM D (Unknown)	36
<i>ssp. lactis</i> biovar <i>diacetylactis</i>	SM E (Unknown)	36
<i>ssp. lactis</i>	SM F (Unknown)	36
<i>ssp. cremoris</i>	SM G (Unknown)	36
<i>ssp. cremoris</i>	SM H (C)	36
<i>ssp. cremoris</i>	SM I (C)	36
<i>ssp. cremoris</i>	SM J (C)	36
<i>ssp. cremoris</i>	SM K (Unknown)	36
<i>ssp. lactis</i> biovar <i>diacetylactis</i>	SM L (Unknown)	36
<i>ssp. lactis</i> biovar <i>diacetylactis</i>	SM M (Unknown)	36
<i>ssp. lactis</i>	SM N (C)	36
<i>ssp. cremoris</i>	SM O (C)	36
<i>ssp. lactis</i>	SM P (C)	36
<i>ssp. cremoris</i>	SM Q (C)	36
<i>ssp. cremoris</i>	SM R (C)	36
<i>ssp. cremoris</i>	SM S (C)	36
<i>ssp. cremoris</i>	SM T (C)	36
<i>ssp. cremoris</i>	SM 1 (C)	36
<i>ssp. lactis</i> biovar <i>diacetylactis</i>	SM 2 (B)	36
<i>ssp. cremoris</i>	SM 3 (Unknown)	36
<i>ssp. cremoris</i>	SM 4 (C)	36
<i>ssp. lactis</i> biovar <i>diacetylactis</i>	SM 5 (C)	36
<i>ssp. lactis</i> biovar <i>diacetylactis</i>	SM 6 (B)	36
<i>ssp. cremoris</i>	SM 7 (C)	36
<i>ssp. lactis</i> biovar <i>diacetylactis</i>	SM 8 (Unknown)	36
<i>ssp. lactis</i> biovar <i>diacetylactis</i>	SM 9 (Unknown)	36
<i>ssp. cremoris</i>	SM 10 (B)	36
<i>ssp. cremoris</i>	SM 11 (C)	36
<i>ssp. lactis</i>	SM 12 (Unknown)	36
<i>ssp. lactis</i>	SM 13 (C)	36
<i>ssp. lactis</i> biovar <i>diacetylactis</i>	SM 14 (B)	36
<i>ssp. lactis</i>	SM 15 (C)	36
<i>ssp. lactis</i> biovar <i>diacetylactis</i>	SM 16 (Unknown)	36
<i>ssp. lactis</i> biovar <i>diacetylactis</i>	SM 17 (B)	36
<i>ssp. cremoris</i>	SM 18 (C)	36
<i>ssp. cremoris</i>	SM 19 (C)	36
<i>ssp. cremoris</i>	SM 20 (Unknown)	36
<i>ssp. cremoris</i>	UC509.9 (A). Host for Tuc2009	49
<i>ssp. cremoris</i>	158 (A). Host for P1084	50
<i>ssp. lactis</i>	IL1403 (B). Host for P008	51
Additional phages	Features	
Tuc2009	P335 group phage. Negative control for Phi15-NPS	49

P1084	936 group phage with spiral like decorations. Genome not sequenced	Personal communication
P008	936 group phage. Negative control for TpxE antibodies	⁵²
Plasmids	Features	Source
pTX8048	Chloramphenicol resistant	⁴⁵
pTX15_NPS	pTX8048 derivative encoding <i>npsPhi15</i>	This study
pNZtpeX	pNZ8048 derivative encoding <i>fiberPhiC0139</i>	This study
Primers	Features	Source
mcsPTX8048 F	TAACCTGGCCGGTTCTGGTTC	This study
mcsPTX8048 R	CGTTTCAAGCCTTGGTTTTTC	This study
Phi15_NPSF	aaattt GGATCC ATGAGTTTAGATAAATTTTAG	This study
Phi15_NPSR	aaattt TCTAGACTA ATCAATGAAATAGCTTG	This study
C0139tpeX_F	agcagc CCATGG cc CACCATCACCATCACCAT tcttctggt GACGGGGCTCACCACG ^c	This study
C0139 tpeX_R	agcagc TCTAGATTATTCTACTATTTTTTTTCCAGGTATATC	This study

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132 **Text file 1. The core genes of the 936 group phage and their predicted function**

133	Protein Function	ID
134	Small Terminase	340_001
135	Small Terminase	645_001
136	Small Terminase	936_001
137	Small Terminase	ASCC191_0001
138	Small Terminase	ASCC273_0001
139	Small Terminase	ASCC281_0001
140	Small Terminase	ASCC284_0001
141	Small Terminase	ASCC287_0001
142	Small Terminase	ASCC310_0001
143	Small Terminase	ASCC324_0001
144	Small Terminase	ASCC337_0001
145	Small Terminase	ASCC356_0001
146	Small Terminase	ASCC358_0001
147	Small Terminase	ASCC365_0001
148	Small Terminase	ASCC368_0001
149	Small Terminase	ASCC395_0001
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160	Small Terminase	ASCC506_0001
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163	Small Terminase	ASCC532_0001
164	Small Terminase	ASCC544_0001
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166	Small Terminase	CB14_0001
167	Small Terminase	CB19_0001
168	Small Terminase	CB20_0001
169	Small Terminase	LPPV008_gp01
170	Small Terminase	LPV712_gp001
171	Small Terminase	P113G_001
172	Small Terminase	P272_001
173	Small Terminase	P475_001
174	Small Terminase	P680_01
175	Small Terminase	PastusJM3_01
176	Small Terminase	Phi10.5_01
177	Small Terminase	Phi109_01
178	Small Terminase	Phi114_01
179	Small Terminase	Phi129_01
180	Small Terminase	Phi1316_01
181	Small Terminase	Phi145_01

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190	Small Terminase	Phi40_01
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214	Small Terminase	SL4_0001
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216	Small Terminase	bIBB29_gp01
217	Small Terminase	bIL170p01
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219	Small Terminase	jj50_ORF1
220	Small Terminase	jm1_0001
221	Small Terminase	p2_0001
222	Small Terminase	phi7_01
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224	Large terminase	340_002
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226	Large terminase	936_002
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251	Large terminase	ASCC527_0003
252	Large terminase	ASCC531_0004
253	Large terminase	ASCC532_0004
254	Large terminase	ASCC544_0003
255	Large terminase	CB13_0003
256	Large terminase	CB14_0003
257	Large terminase	CB19_0003
258	Large terminase	CB20_0003
259	Large terminase	LPPV008_gp02
260	Large terminase	LPV712_gp002
261	Large terminase	P113G_002
262	Large terminase	P272_002
263	Large terminase	P475_002
264	Large terminase	P680_02
265	Large terminase	PastusJM3_02
266	Large terminase	Phi10.5_03
267	Large terminase	Phi109_04
268	Large terminase	Phi114_03
269	Large terminase	Phi129_02
270	Large terminase	Phi1316_02
271	Large terminase	Phi145_03
272	Large terminase	Phi155_04
273	Large terminase	Phi15_03
274	Large terminase	Phi16_04
275	Large terminase	Phi17_04
276	Large terminase	Phi19.2_02
277	Large terminase	Phi19.3_02
278	Large terminase	Phi19_02
279	Large terminase	Phi4.2_03
280	Large terminase	Phi40_04
281	Large terminase	Phi43_02

282	Large terminase	Phi44_03
283	Large terminase	Phi4_02
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295	Large terminase	PhiG_03
296	Large terminase	PhiJF1_03
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305	Large terminase	ViridisJM2_gp02
306	Large terminase	bIBB29_gp02
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308	Large terminase	fd13_002
309	Large terminase	jj50_ORF2
310	Large terminase	jm1_0002
311	Large terminase	p2_0002
312	Large terminase	phi7_02
313	Large terminase	sk1p02
314	HNH Endonuclease	340_003
315	HNH Endonuclease	645_003
316	HNH Endonuclease	936_003
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322	HNH Endonuclease	ASCC310_0005
323	HNH Endonuclease	ASCC324_0004
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325	HNH Endonuclease	ASCC356_0005
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327	HNH Endonuclease	ASCC365_0005
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341	HNH Endonuclease	ASCC527_0004
342	HNH Endonuclease	ASCC531_0005
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344	HNH Endonuclease	ASCC544_0004
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346	HNH Endonuclease	CB14_0004
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351	HNH Endonuclease	P113G_003
352	HNH Endonuclease	P272_003
353	HNH Endonuclease	P475_003
354	HNH Endonuclease	P680_03
355	HNH Endonuclease	PastusJM3_03
356	HNH Endonuclease	Phi10.5_04
357	HNH Endonuclease	Phi109_05
358	HNH Endonuclease	Phi114_04
359	HNH Endonuclease	Phi129_03
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361	HNH Endonuclease	Phi145_04
362	HNH Endonuclease	Phi155_05
363	HNH Endonuclease	Phi15_04
364	HNH Endonuclease	Phi16_05
365	HNH Endonuclease	Phi17_05
366	HNH Endonuclease	Phi19.2_03
367	HNH Endonuclease	Phi19.3_03
368	HNH Endonuclease	Phi19_03
369	HNH Endonuclease	Phi4.2_04
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371	HNH Endonuclease	Phi43_03
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373	HNH Endonuclease	Phi4_03
374	HNH Endonuclease	Phi5.12_04
375	HNH Endonuclease	Phi91127_05
376	HNH Endonuclease	Phi93_06
377	HNH Endonuclease	PhiA1127_04
378	HNH Endonuclease	PhiA16_03
379	HNH Endonuclease	PhiB1127_03
380	HNH Endonuclease	PhiC0139_03
381	HNH Endonuclease	PhiD.18_03

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383 HNH Endonuclease PhiF.17_04
384 HNH Endonuclease PhiF0139_04
385 HNH Endonuclease PhiG_04
386 HNH Endonuclease PhiJF1_04
387 HNH Endonuclease PhiL.18_05
388 HNH Endonuclease PhiL.6_05
389 HNH Endonuclease PhiLj_03
390 HNH Endonuclease PhiM.16_05
391 HNH Endonuclease PhiM.5_05
392 HNH Endonuclease PhiM1127_06
393 HNH Endonuclease PhiS0139_03
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395 HNH Endonuclease ViridisJM2_gp03
396 HNH Endonuclease bIBB29_gp03
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400 HNH Endonuclease jm1_0003
401 HNH Endonuclease p2_0003
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403 HNH Endonuclease sk1p03
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432 Portal ASCC531_0006
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434 Portal ASCC544_0005
435 Portal CB13_0005
436 Portal CB14_0005
437 Portal CB19_0005
438 Portal CB20_0005
439 Portal LPPV008_gp04
440 Portal LPV712_gp004
441 Portal P113G_004
442 Portal P272_004
443 Portal P475_004
444 Portal P680_04
445 Portal PastusJM3_04
446 Portal Phi10.5_05
447 Portal Phi109_06
448 Portal Phi114_05
449 Portal Phi129_04
450 Portal Phi1316_04
451 Portal Phi145_05
452 Portal Phi155_06
453 Portal Phi15_05
454 Portal Phi16_06
455 Portal Phi17_06
456 Portal Phi19.2_04
457 Portal Phi19.3_04
458 Portal Phi19_04
459 Portal Phi4.2_05
460 Portal Phi40_06
461 Portal Phi43_04
462 Portal Phi44_05
463 Portal Phi4_04
464 Portal Phi5.12_05
465 Portal Phi91127_06
466 Portal Phi93_07
467 Portal PhiA1127_05
468 Portal PhiA16_04
469 Portal PhiB1127_04
470 Portal PhiC0139_04
471 Portal PhiD.18_04
472 Portal PhiE1127_05
473 Portal PhiF.17_05
474 Portal PhiF0139_05
475 Portal PhiG_05
476 Portal PhiJF1_05
477 Portal PhiL.18_06
478 Portal PhiL.6_06
479 Portal PhiLj_04
480 Portal PhiM.16_06
481 Portal PhiM.5_06

482 Portal PhiM1127_07
483 Portal PhiS0139_04
484 Portal SL4_0005
485 Portal ViridisJM2_gp04
486 Portal bIBB29_gp04
487 Portal bIL170p04
488 Portal fd13_004
489 Portal jj50_ORF4
490 Portal jm1_0004
491 Portal p2_0004
492 Portal phi7_04
493 Portal sk1p04
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523 Protease ASCC532_0007
524 Protease ASCC544_0006
525 Protease CB13_0006
526 Protease CB14_0006
527 Protease CB19_0006
528 Protease CB20_0006
529 Protease LPPV008_gp05
530 Protease LPV712_gp005
531 Protease P113G_005

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533	Protease	P475_005
534	Protease	P680_05
535	Protease	PastusJM3_05
536	Protease	Phi10.5_06
537	Protease	Phi109_07
538	Protease	Phi114_06
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546	Protease	Phi19.2_05
547	Protease	Phi19.3_05
548	Protease	Phi19_05
549	Protease	Phi4.2_06
550	Protease	Phi40_07
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552	Protease	Phi44_06
553	Protease	Phi4_05
554	Protease	Phi5.12_06
555	Protease	Phi91127_07
556	Protease	Phi93_08
557	Protease	PhiA1127_06
558	Protease	PhiA16_05
559	Protease	PhiB1127_05
560	Protease	PhiC0139_05
561	Protease	PhiD.18_05
562	Protease	PhiE1127_06
563	Protease	PhiF.17_06
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565	Protease	PhiG_06
566	Protease	PhiJF1_06
567	Protease	PhiL.18_07
568	Protease	PhiL.6_07
569	Protease	PhiLj_05
570	Protease	PhiM.16_07
571	Protease	PhiM.5_07
572	Protease	PhiM1127_08
573	Protease	PhiS0139_05
574	Protease	SL4_0006
575	Protease	ViridisJM2_gp05
576	Protease	bIBB29_gp05
577	Protease	bIL170p05
578	Protease	fd13_005
579	Protease	jj50_ORF5
580	Protease	jm1_0005
581	Protease	p2_0005

582	Protease	phi7_05
583	Protease	sk1p05
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585	Major capsid protein	645_006
586	Major capsid protein	936_006
587	Major capsid protein	ASCC191_0007
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615	Major capsid protein	CB13_0007
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626	Major capsid protein	PastusJM3_06
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645	Major capsid protein	Phi5.12_07
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657	Major capsid protein	PhiJF1_07
658	Major capsid protein	PhiL.18_08
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661	Major capsid protein	PhiM.16_08
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734	Hypothetical protein	Phi44_08
735	Hypothetical protein	Phi4_07
736	Hypothetical protein	Phi5.12_08
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747	Hypothetical protein	PhiG_08
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752	Hypothetical protein	PhiM.16_09
753	Hypothetical protein	PhiM.5_09
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759	Hypothetical protein	bIL170p08
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761	Hypothetical protein	jj50_ORF7
762	Hypothetical protein	jm1_0007
763	Hypothetical protein	p2_0007
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765	Hypothetical protein	sk1p07
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768	Connector	936_008
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803	Connector	P113G_008
804	Connector	P272_008
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828	Connector	Phi93_11
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841	Connector	PhiLj_08
842	Connector	PhiM.16_10
843	Connector	PhiM.5_10
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847	Connector	ViridisJM2_gp08
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852	Connector	jm1_0008
853	Connector	p2_0008
854	Connector	phi7_08
855	Connector	sk1p08
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901	Stopper	ASCC544_0010
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906	Stopper	CB20_0010
907	Stopper	LPPV008_gp10
908	Stopper	LPV712_gp009
909	Stopper	P113G_009
910	Stopper	P272_009
911	Stopper	P475_0010
912	Stopper	P680_09
913	Stopper	PastusJM3_09
914	Stopper	Phi10.5_11
915	Stopper	Phi109_12
916	Stopper	Phi114_10
917	Stopper	Phi129_09
918	Stopper	Phi1316_09
919	Stopper	Phi145_11
920	Stopper	Phi155_11
921	Stopper	Phi15_10
922	Stopper	Phi16_12
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927	Stopper	Phi4.2_10
928	Stopper	Phi40_12
929	Stopper	Phi43_09
930	Stopper	Phi44_10
931	Stopper	Phi4_10

932	Stopper	Phi5.12_10
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934	Stopper	Phi93_13
935	Stopper	PhiA1127_10
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937	Stopper	PhiB1127_09
938	Stopper	PhiC0139_09
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942	Stopper	PhiF0139_10
943	Stopper	PhiG_10
944	Stopper	PhiJF1_11
945	Stopper	PhiL.18_11
946	Stopper	PhiL.6_11
947	Stopper	PhiLj_09
948	Stopper	PhiM.16_11
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951	Stopper	PhiS0139_09
952	Stopper	SL4_0011
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954	Stopper	bIBB29_gp09
955	Stopper	bIL170p10
956	Stopper	fd13_0010
957	Stopper	jj50_ORF9
958	Stopper	jm1_0009
959	Stopper	p2_0009
960	Stopper	phi7_09
961	Stopper	sk1p09
962	Tail terminator	340_0011
963	Tail terminator	645_0010
964	Tail terminator	936_0010
965	Tail terminator	ASCC191_0011
966	Tail terminator	ASCC273_0011
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999	Tail terminator	P113G_0010
1000	Tail terminator	P272_0010
1001	Tail terminator	P475_0011
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1005	Tail terminator	Phi109_13
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1007	Tail terminator	Phi129_10
1008	Tail terminator	Phi1316_10
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1010	Tail terminator	Phi155_12
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1015	Tail terminator	Phi19.3_10
1016	Tail terminator	Phi19_10
1017	Tail terminator	Phi4.2_11
1018	Tail terminator	Phi40_13
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1020	Tail terminator	Phi44_11
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1022	Tail terminator	Phi5.12_11
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1024	Tail terminator	Phi93_14
1025	Tail terminator	PhiA1127_11
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1027	Tail terminator	PhiB1127_10
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1034	Tail terminator	PhiJF1_12
1035	Tail terminator	PhiL.18_12
1036	Tail terminator	PhiL.6_12
1037	Tail terminator	PhiLj_10
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1039	Tail terminator	PhiM.5_12
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1556	Tail associated lysin	Phi19_17
1557	Tail associated lysin	Phi4.2_18
1558	Tail associated lysin	Phi40_20
1559	Tail associated lysin	Phi43_17
1560	Tail associated lysin	Phi44_18
1561	Tail associated lysin	Phi4_18
1562	Tail associated lysin	Phi5.12_18
1563	Tail associated lysin	Phi91127_19
1564	Tail associated lysin	Phi93_21
1565	Tail associated lysin	PhiA1127_18
1566	Tail associated lysin	PhiA16_17
1567	Tail associated lysin	PhiB1127_18
1568	Tail associated lysin	PhiC0139_18
1569	Tail associated lysin	PhiD.18_17
1570	Tail associated lysin	PhiE1127_18
1571	Tail associated lysin	PhiF.17_18
1572	Tail associated lysin	PhiF0139_18
1573	Tail associated lysin	PhiG_18
1574	Tail associated lysin	PhiJF1_19
1575	Tail associated lysin	PhiL.18_19
1576	Tail associated lysin	PhiL.6_19
1577	Tail associated lysin	PhiLj_17
1578	Tail associated lysin	PhiM.16_19
1579	Tail associated lysin	PhiM.5_19
1580	Tail associated lysin	PhiM1127_20
1581	Tail associated lysin	PhiS0139_17

1582	Tail associated lysin	SL4_0018
1583	Tail associated lysin	ViridisJM2_gp17
1584	Tail associated lysin	bIBB29_gp17
1585	Tail associated lysin	bIL170p18
1586	Tail associated lysin	fd13_0018
1587	Tail associated lysin	jj50_ORF16
1588	Tail associated lysin	jm1_0017
1589	Tail associated lysin	p2_0016
1590	Tail associated lysin	phi7_18
1591	Tail associated lysin	sk1p16
1592	Hypothetical protein	340_0019
1593	Hypothetical protein	645_0018
1594	Hypothetical protein	936_0017
1595	Hypothetical protein	ASCC191_0020
1596	Hypothetical protein	ASCC273_0020
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1617	Hypothetical protein	ASCC502_0020
1618	Hypothetical protein	ASCC506_0020
1619	Hypothetical protein	ASCC527_0020
1620	Hypothetical protein	ASCC531_0020
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1622	Hypothetical protein	ASCC544_0020
1623	Hypothetical protein	CB13_0019
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1625	Hypothetical protein	CB19_0019
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1627	Hypothetical protein	LPPV008_gp19
1628	Hypothetical protein	LPV712_gp018
1629	Hypothetical protein	P113G_0018
1630	Hypothetical protein	P272_0018
1631	Hypothetical protein	P475_0019

1632	Hypothetical protein	P680_18
1633	Hypothetical protein	PastusJM3_18
1634	Hypothetical protein	Phi10.5_19
1635	Hypothetical protein	Phi109_21
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1657	Hypothetical protein	PhiB1127_19
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1660	Hypothetical protein	PhiE1127_19
1661	Hypothetical protein	PhiF.17_19
1662	Hypothetical protein	PhiF0139_19
1663	Hypothetical protein	PhiG_19
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1665	Hypothetical protein	PhiL.18_20
1666	Hypothetical protein	PhiL.6_20
1667	Hypothetical protein	PhiLj_18
1668	Hypothetical protein	PhiM.16_20
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1670	Hypothetical protein	PhiM1127_21
1671	Hypothetical protein	PhiS0139_18
1672	Hypothetical protein	SL4_0019
1673	Hypothetical protein	ViridisJM2_gp18
1674	Hypothetical protein	bIBB29_gp18
1675	Hypothetical protein	bIL170p19
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1677	Hypothetical protein	jj50_ORF17
1678	Hypothetical protein	jm1_0018
1679	Hypothetical protein	p2_0017
1680	Hypothetical protein	phi7_19
1681	Hypothetical protein	sk1p17

1682	Receptor binding protein	340_0020
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1684	Receptor binding protein	936_0018
1685	Receptor binding protein	ASCC191_0021
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1713	Receptor binding protein	CB13_0020
1714	Receptor binding protein	CB14_0020
1715	Receptor binding protein	CB19_0020
1716	Receptor binding protein	CB20_0020
1717	Receptor binding protein	LPPV008_gp20
1718	Receptor binding protein	LPV712_gp019
1719	Receptor binding protein	P113G_0019
1720	Receptor binding protein	P272_0019
1721	Receptor binding protein	P475_0020
1722	Receptor binding protein	P680_19
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1730	Receptor binding protein	Phi155_21
1731	Receptor binding protein	Phi15_20

1732	Receptor binding protein	Phi16_22
1733	Receptor binding protein	Phi17_21
1734	Receptor binding protein	Phi19.2_19
1735	Receptor binding protein	Phi19.3_19
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1743	Receptor binding protein	Phi5.12_20
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1769	Receptor binding protein	jm1_0019
1770	Receptor binding protein	p2_0018
1771	Receptor binding protein	phi7_20
1772	Receptor binding protein	sk1p18
1773	Holin 340_0021	
1774	Holin 645_0020	
1775	Holin 936_0019	
1776	Holin ASCC191_0022	
1777	Holin ASCC273_0022	
1778	Holin ASCC281_0022	
1779	Holin ASCC284_0022	
1780	Holin ASCC287_0022	
1781	Holin ASCC310_0022	

1782	Holin	ASCC324_0022
1783	Holin	ASCC337_0022
1784	Holin	ASCC356_0022
1785	Holin	ASCC358_0022
1786	Holin	ASCC365_0022
1787	Holin	ASCC368_0022
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1789	Holin	ASCC397_0022
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1791	Holin	ASCC454_0022
1792	Holin	ASCC460_0022
1793	Holin	ASCC465_0022
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1795	Holin	ASCC476_0022
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1797	Holin	ASCC497_0022
1798	Holin	ASCC502_0022
1799	Holin	ASCC506_0022
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1805	Holin	CB14_0021
1806	Holin	CB19_0021
1807	Holin	CB20_0021
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1809	Holin	LPV712_gp020
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1823	Holin	Phi16_23
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1827	Holin	Phi19_20
1828	Holin	Phi4.2_22
1829	Holin	Phi40_23
1830	Holin	Phi43_20
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1832	Holin	Phi4_21
1833	Holin	Phi5.12_21
1834	Holin	Phi91127_22
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1836	Holin	PhiA1127_21
1837	Holin	PhiA16_20
1838	Holin	PhiB1127_21
1839	Holin	PhiC0139_21
1840	Holin	PhiD.18_20
1841	Holin	PhiE1127_21
1842	Holin	PhiF.17_21
1843	Holin	PhiF0139_21
1844	Holin	PhiG_21
1845	Holin	PhiJF1_22
1846	Holin	PhiL.18_22
1847	Holin	PhiL.6_22
1848	Holin	PhiLj_20
1849	Holin	PhiM.16_22
1850	Holin	PhiM.5_22
1851	Holin	PhiM1127_23
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1854	Holin	ViridisJM2_gp20
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1858	Holin	jj50_ORF19
1859	Holin	jm1_0020
1860	Holin	p2_0019
1861	Holin	phi7_21
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1863	Lysin	340_0022
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1900	Lysin	P113G_0021
1901	Lysin	P272_0021
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1906	Lysin	Phi109_24
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1908	Lysin	Phi129_21
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1910	Lysin	Phi145_23
1911	Lysin	Phi155_23
1912	Lysin	Phi15_22
1913	Lysin	Phi16_24
1914	Lysin	Phi17_23
1915	Lysin	Phi19.2_21
1916	Lysin	Phi19.3_21
1917	Lysin	Phi19_21
1918	Lysin	Phi4.2_23
1919	Lysin	Phi40_24
1920	Lysin	Phi43_21
1921	Lysin	Phi44_22
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1923	Lysin	Phi5.12_22
1924	Lysin	Phi91127_23
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1928	Lysin	PhiB1127_22
1929	Lysin	PhiC0139_22
1930	Lysin	PhiD.18_21
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1932 Lysin PhiF.17_22
1933 Lysin PhiF0139_22
1934 Lysin PhiG_22
1935 Lysin PhiJF1_23
1936 Lysin PhiL.18_23
1937 Lysin PhiL.6_23
1938 Lysin PhiLj_21
1939 Lysin PhiM.16_23
1940 Lysin PhiM.5_23
1941 Lysin PhiM1127_24
1942 Lysin PhiS0139_21
1943 Lysin SL4_0022
1944 Lysin ViridisJM2_gp21
1945 Lysin bIBB29_gp21
1946 Lysin bIL170p22
1947 Lysin fd13_0022
1948 Lysin jj50_ORF20
1949 Lysin jm1_0021
1950 Lysin p2_0020
1951 Lysin phi7_22
1952 Lysin sk1p20
1953 Hypothetical protein 340_0026
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1955 Hypothetical protein 936_0022
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1986	Hypothetical protein	CB19_0024
1987	Hypothetical protein	CB20_0024
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1990	Hypothetical protein	P113G_0026
1991	Hypothetical protein	P272_0026
1992	Hypothetical protein	P475_0026
1993	Hypothetical protein	P680_25
1994	Hypothetical protein	PastusJM3_24
1995	Hypothetical protein	Phi10.5_26
1996	Hypothetical protein	Phi109_28
1997	Hypothetical protein	Phi114_24
1998	Hypothetical protein	Phi129_23
1999	Hypothetical protein	Phi1316_22
2000	Hypothetical protein	Phi145_27
2001	Hypothetical protein	Phi155_27
2002	Hypothetical protein	Phi15_25
2003	Hypothetical protein	Phi16_28
2004	Hypothetical protein	Phi17_27
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2006	Hypothetical protein	Phi19.3_22
2007	Hypothetical protein	Phi19_22
2008	Hypothetical protein	Phi4.2_27
2009	Hypothetical protein	Phi40_28
2010	Hypothetical protein	Phi43_23
2011	Hypothetical protein	Phi44_25
2012	Hypothetical protein	Phi4_23
2013	Hypothetical protein	Phi5.12_24
2014	Hypothetical protein	Phi91127_27
2015	Hypothetical protein	Phi93_29
2016	Hypothetical protein	PhiA1127_23
2017	Hypothetical protein	PhiA16_22
2018	Hypothetical protein	PhiB1127_23
2019	Hypothetical protein	PhiC0139_23
2020	Hypothetical protein	PhiD.18_23
2021	Hypothetical protein	PhiE1127_25
2022	Hypothetical protein	PhiF.17_24
2023	Hypothetical protein	PhiF0139_24
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2027	Hypothetical protein	PhiL.6_27
2028	Hypothetical protein	PhiLj_22
2029	Hypothetical protein	PhiM.16_26
2030	Hypothetical protein	PhiM.5_27
2031	Hypothetical protein	PhiM1127_28

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2033	Hypothetical protein	SL4_0025
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2035	Hypothetical protein	bIBB29_gp25
2036	Hypothetical protein	bIL170p27
2037	Hypothetical protein	fd13_0024
2038	Hypothetical protein	jj50_ORF21
2039	Hypothetical protein	jm1_0023
2040	Hypothetical protein	p2_0022
2041	Hypothetical protein	phi7_25
2042	Hypothetical protein	sk1p22
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2087	Hypothetical protein	Phi114_26
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2097	Hypothetical protein	Phi19_24
2098	Hypothetical protein	Phi4.2_29
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2101	Hypothetical protein	Phi44_26
2102	Hypothetical protein	Phi4_25
2103	Hypothetical protein	Phi5.12_25
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2105	Hypothetical protein	Phi93_32
2106	Hypothetical protein	PhiA1127_25
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2109	Hypothetical protein	PhiC0139_25
2110	Hypothetical protein	PhiD.18_25
2111	Hypothetical protein	PhiE1127_27
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2114	Hypothetical protein	PhiG_26
2115	Hypothetical protein	PhiJF1_27
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2117	Hypothetical protein	PhiL.6_29
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2124	Hypothetical protein	ViridisJM2_gp24
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2700	RuvC-Like holliday endonuclease	ASCC502_0058
2701	RuvC-Like holliday endonuclease	ASCC506_0058
2702	RuvC-Like holliday endonuclease	ASCC527_0058
2703	RuvC-Like holliday endonuclease	ASCC531_0057
2704	RuvC-Like holliday endonuclease	ASCC532_0057
2705	RuvC-Like holliday endonuclease	ASCC544_0058
2706	RuvC-Like holliday endonuclease	CB13_0053
2707	RuvC-Like holliday endonuclease	CB14_0050
2708	RuvC-Like holliday endonuclease	CB19_0049
2709	RuvC-Like holliday endonuclease	CB20_0049
2710	RuvC-Like holliday endonuclease	LPPV008_gp55
2711	RuvC-Like holliday endonuclease	LPV712_gp053
2712	RuvC-Like holliday endonuclease	P113G_0055
2713	RuvC-Like holliday endonuclease	P272_0058
2714	RuvC-Like holliday endonuclease	P475_0055
2715	RuvC-Like holliday endonuclease	P680_49
2716	RuvC-Like holliday endonuclease	PastusJM3_48
2717	RuvC-Like holliday endonuclease	Phi10.5_62
2718	RuvC-Like holliday endonuclease	Phi109_53
2719	RuvC-Like holliday endonuclease	Phi114_52
2720	RuvC-Like holliday endonuclease	Phi129_53
2721	RuvC-Like holliday endonuclease	Phi1316_53
2722	RuvC-Like holliday endonuclease	Phi145_53
2723	RuvC-Like holliday endonuclease	Phi155_53
2724	RuvC-Like holliday endonuclease	Phi15_54
2725	RuvC-Like holliday endonuclease	Phi16_55
2726	RuvC-Like holliday endonuclease	Phi17_55
2727	RuvC-Like holliday endonuclease	Phi19.2_54
2728	RuvC-Like holliday endonuclease	Phi19.3_51
2729	RuvC-Like holliday endonuclease	Phi19_49
2730	RuvC-Like holliday endonuclease	Phi4.2_57
2731	RuvC-Like holliday endonuclease	Phi40_55

2732	RuvC-Like holliday endonuclease	Phi43_53
2733	RuvC-Like holliday endonuclease	Phi44_51
2734	RuvC-Like holliday endonuclease	Phi4_50
2735	RuvC-Like holliday endonuclease	Phi5.12_52
2736	RuvC-Like holliday endonuclease	Phi91127_55
2737	RuvC-Like holliday endonuclease	Phi93_54
2738	RuvC-Like holliday endonuclease	PhiA1127_51
2739	RuvC-Like holliday endonuclease	PhiA16_48
2740	RuvC-Like holliday endonuclease	PhiB1127_52
2741	RuvC-Like holliday endonuclease	PhiC0139_52
2742	RuvC-Like holliday endonuclease	PhiD.18_52
2743	RuvC-Like holliday endonuclease	PhiE1127_58
2744	RuvC-Like holliday endonuclease	PhiF.17_55
2745	RuvC-Like holliday endonuclease	PhiF0139_55
2746	RuvC-Like holliday endonuclease	PhiG_56
2747	RuvC-Like holliday endonuclease	PhiJF1_56
2748	RuvC-Like holliday endonuclease	PhiL.18_54
2749	RuvC-Like holliday endonuclease	PhiL.6_57
2750	RuvC-Like holliday endonuclease	PhiLj_48
2751	RuvC-Like holliday endonuclease	PhiM.16_53
2752	RuvC-Like holliday endonuclease	PhiM.5_56
2753	RuvC-Like holliday endonuclease	PhiM1127_58
2754	RuvC-Like holliday endonuclease	PhiS0139_52
2755	RuvC-Like holliday endonuclease	SL4_0050
2756	RuvC-Like holliday endonuclease	ViridisJM2_gp58
2757	RuvC-Like holliday endonuclease	bIBB29_gp53
2758	RuvC-Like holliday endonuclease	bIL170p63
2759	RuvC-Like holliday endonuclease	fd13_0052
2760	RuvC-Like holliday endonuclease	jj50_ORF48
2761	RuvC-Like holliday endonuclease	jm1_0050
2762	RuvC-Like holliday endonuclease	p2_0048
2763	RuvC-Like holliday endonuclease	phi7_55
2764	RuvC-Like holliday endonuclease	sk1p55
2765		