

Supplemental Material

belonging to:

Comparative genomics to examine the endophytic potential of *Pantoea agglomerans* DAPP-PG 734

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Text S1: Metabolic versatility in *Pantoea agglomerans* DAPP-PG 734.

The plasmids 1 and 3 in *P. agglomerans* DAPP-PG 734 carries several gene clusters as most were observed in *P. vagans* C9-1 on pPag1 and pPag3 [1, 2] for metabolic purpose and biosynthesis of secondary metabolites (**Figure S2, Figure S3**). However, the plasmids from DAPP-PG 734 are also containing some variation compared to the plasmids of C9-1.

Plasmid 1 include a complete gene cluster (*malGFEKLMQPT*) for maltose metabolism ([\(DAPPPG734_22555 - DAPPPG734_22605\)](#)). The maltose/maltodextrin system is regulated by an activator MalT, and contains eight further regulated genes, which are shaped for the transport and metabolism of maltose and maltodextrins. Six genes of this cluster encode a high-affinity and binding protein-dependent ABC transporter, called maltoporin, MalM, MalE, MalK and the subunits MalF and MalG [3]. Compared to related strains (**Figure 3, main document**), only two strains showed the absence of the *malGFEKLMQPT* gene cluster. *Pantoea eucalypti* NFPP29 does not contain any plasmids related to plasmid 1 in *P. agglomerans* DAPP-PG 734 or pPag3 in *P. vagans* C9-1 [2]. On the other hand, *P. vagans* FDAARGOS_160 contains a plasmid related to plasmid 1 in DAPP-PG 734, but it lacks all *mal* genes.

Other clusters for carbohydrate metabolism including arabinogalactan (*ganKEFGABCLR*) [[4\(DAPPPG734_23085 - DAPPPG734_23130\)](#)] and fructoselysine (*frlABDR*) ([\(DAPPPG734_21510 - DAPPPG734_21525\)](#)) are located on plasmid 1 as observed in a large group of *Pantoea* strains which include a large universal *Pantoea* plasmid (LPP-1)[5]. The *frlABDR* gene cluster consist of four genes encoding for fructoselysine permease FrlA, fructoselysine-6-phosphate deglycase FrlB, fructoselysine-6-phosphatase FrlD and regulator of fructoselysine operon FrlR (**Figure S4**). The presence of the *frlABDR* gene cluster is very variable within the compared strains (**Figure 3, main document**). This indicated that *frlABDR* is rather a variable trait within the species [5]. Therefore, further analyses are necessary to determine the role of this gene cluster within the species.

Corresponding to the production of the typically yellow pigment [6], *P. agglomerans* DAPP-PG 734 contains six genes (*crtEXYIBZ*) for carotenoid biosynthesis as observed in *P. vagans* C9-1 on pPag3 [2], which are located on plasmid 1 ([\(DAPPPG734_22760 - DAPPPG734_22785\)](#)). Carotenoids can play an important role in photooxidative damage protection and protection against environmental stress [7]. The *crtEXYIBZ* gene cluster were identified in almost all other strains (**Figure 3, main document**), except *P. eucalypti* NFPP29, which does not have a plasmid related to plasmid 1 in *P. agglomerans* DAPP-PG 734.

Furthermore, the gene cluster for thiamine biosynthesis is also present in DAPP-PG 734 on plasmid 1 ([\(DAPPPG734_22825 - DAPPPG734_22840\)](#)) and consists of four genes (*thiOSGF*) as discovered in *P. vagans* C9-1 on pPag3 [2]. Recent results showed that the biosynthesis of thiamine has an impact of enhancing the biosynthesis of exopolysaccharides (EPS) in *Erwinia amylovora* which cause

necrotrophic fire blight disease of apple, pear and other rosaceous plants [8]. In comparison, the gene cluster *thiOSGF* was only absent in *Pantoea* sp. PMG_056 and *P. eucalypti* NFPP29 (**Figure 3, main document**).

A gene cluster for encoding a heavy metal reduction of arsenate is also found on the plasmid 1 in DAPP-PG 734 ([DAPPPG734_22475 - DAPPPG734_22490](#)). In addition, some *P. agglomerans* strains contain an *arsH* gene encoding a putative flavoprotein [9]. The presence of the *arsCBRH* gene cluster is also here very variable within the compared strains (**Figure 3, main document**), indicating that it is rather a variable trait within the species [9]. It is important to mention that most strains do not include the gene *arsH* and were therefore marked as partially containing the gene cluster. Additional research *in vitro* will be necessary to indicate the diversification and presence of heavy metal reduction within the species. A further gene cluster for inner membrane iron and manganese transporter (*sitABCD*) as observed on LPP-1 [5] is also located on plasmid 1.

Based on the genomic analysis, plasmid 3 includes only a complete gene cluster for sucrose metabolism ([DAPPPG734_25120 - DAPPPG734_25140](#)) [1, 10]. Sucrose is the most common disaccharide energy source for phytopathogenic bacteria and consist of a glucose unit linked to a fructose unit through a glycosidic linkage [11]. Four structural genes (*scrABKY*) are responsible for the transport and utilization of sucrose, which includes an ATP-dependent fructokinase, a sucrose-specific porin of the outer membrane, an enzyme of the phosphoenolpyruvate-dependent phosphotransferase system (PTS), and beta-fructofuranosidase fructohydrolase for cleaving sucrose 6-phosphate into alpha-glucose 6-phosphate and beta-fructose. The sucrose metabolic system is regulated by a sucrose operon repressor (ScrR) and is induced in a sucrose-specific manner [12]. In comparison, the *scrABKY* gene cluster was only absent in eight other strains (**Figure 3, main document**). These strains do not contain a plasmid related to plasmid 3 in *P. agglomerans* DAPP-PG 734 or pPag1 in *P. vagans* C9-1 [2].

Genes for sorbitol metabolism as observed in *P. vagans* C9-1 on pPag2 [1] were absent in DAPP-PG 734. Additionally, *P. agglomerans* DAPP-PG 734 contains a gene cluster (*narIJHGK*) for the reduction of nitrate to nitrite which can act as terminal respiratory electron acceptor [13]. This gene cluster is located on the chromosome ([DAPPPG734_11365 - DAPPPG734_11390](#)) directly adjacent to the T6SS-2. A gene for encoding flavorubredoxin is also located in this nitrate reductase metabolism cluster. Flavorubredoxin acts like a reductase partner of the anaerobic nitric oxide reductase where nitric oxide is detoxified by using NADH and flavorubredoxin [14]. Compared to related strains, only ten other strains lack all *nar* genes (**Figure 3, main document**).

Table S1: Antibiotic resistance gene profile in the genome of *Pantoea agglomerans* DAPP-PG 734 as predicted using CARD [15].

Antibiotic Resistance Genes (ARG)	SNP	AMR gene family	Drug class	Resistance mechanism	% Identity	Location	Locus tag
<i>crp</i>		resistance-nodulation-cell division (RND) antibiotic efflux pump	macrolide antibiotic, fluoroquinolone antibiotic, penam	antibiotic efflux	98.57	Chromosome	DAPPPG734_02050
<i>rsmA</i>		resistance-nodulation-cell division (RND) antibiotic efflux pump	fluoroquinolone antibiotic, diaminopyrimidine antibiotic, phenicol antibiotic	antibiotic efflux	89.66	Chromosome	DAPPPG734_16755
<i>Klebsiella pneumoniae kpnH</i>		major facilitator superfamily (MFS) antibiotic efflux pump	macrolide antibiotic, fluoroquinolone antibiotic, aminoglycoside antibiotic, carbapenem, cephalosporin, penam, peptide antibiotic, penem	antibiotic efflux	88.02	Chromosome	DAPPPG734_04800
<i>Escherichia coli ampH</i> beta-lactamase		ampC-type beta-lactamase	cephalosporin, penam	antibiotic inactivation	70.54	Chromosome	DAPPPG734_05630
<i>Klebsiella pneumoniae kpnF</i>		major facilitator superfamily (MFS) antibiotic efflux pump	macrolide antibiotic, aminoglycoside antibiotic, cephalosporin, tetracycline antibiotic, peptide antibiotic, rifamycin antibiotic	antibiotic efflux	75.73	Chromosome	DAPPPG734_08635
<i>adeF</i>		resistance-nodulation-cell division (RND) antibiotic efflux pump	fluoroquinolone antibiotic, tetracycline antibiotic	antibiotic efflux	60.8	Chromosome	DAPPPG734_10495
<i>adeF</i>		resistance-nodulation-cell division (RND) antibiotic efflux pump	fluoroquinolone antibiotic, tetracycline antibiotic	antibiotic target alteration	42.06	Chromosome	DAPPPG734_15020
<i>Morganella morganii gyrB</i> conferring resistance to fluoroquinolones	S4363	fluoroquinolone resistant gyrB	fluoroquinolone antibiotic	antibiotic target alteration	80.85	Chromosome	DAPPPG734_00025
<i>Haemophilus influenzae</i> PBP3 conferring resistance to beta-lactam antibiotics	D350N, S357N	Penicillin-binding protein mutations conferring resistance to beta-lactam antibiotics	cephalosporin, cephamycin, penam	antibiotic target alteration	53.19	Chromosome	DAPPPG734_16625
<i>Escherichia coli</i> EF-Tu mutants conferring resistance to pulvomycin	R234F	elfamycin resistant EF-Tu	elfamycin antibiotic	antibiotic target alteration	91.09	Chromosome	DAPPPG734_02175
<i>Escherichia coli</i> EF-Tu mutants conferring resistance to pulvomycin	R234F	elfamycin resistant EF-Tu	elfamycin antibiotic	antibiotic target alteration	89.57	Chromosome	DAPPPG734_20110

Figure S1: Genomic islands in *Pantoea agglomerans* DAPP-PG 734. This figure shows the circular plot of the genome of *P. agglomerans* DAPP-PG 734 and the predicated genomic islands which are colored based on the prediction methods [16]. Orange indicates genomic islands predicted by SIGI-HMM, blue represent genomic islands using IslandPath-DIMOB method and red shows the genomic islands that were predicted by an integrated analysis.

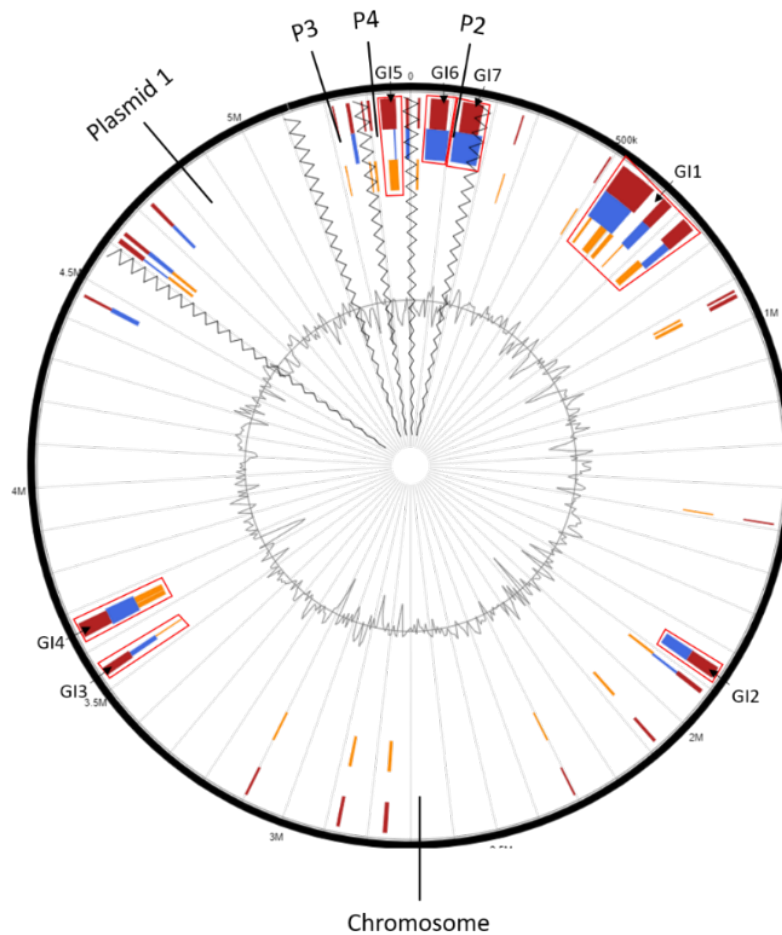


Figure S2: MAUVE alignment in progressive mode of *Pantoea agglomerans* DAPP-PG 734 plasmid 1 and *Pantoea vagans* C9-1 pPag3. Gene clusters for metabolic purpose and different features are indicated.

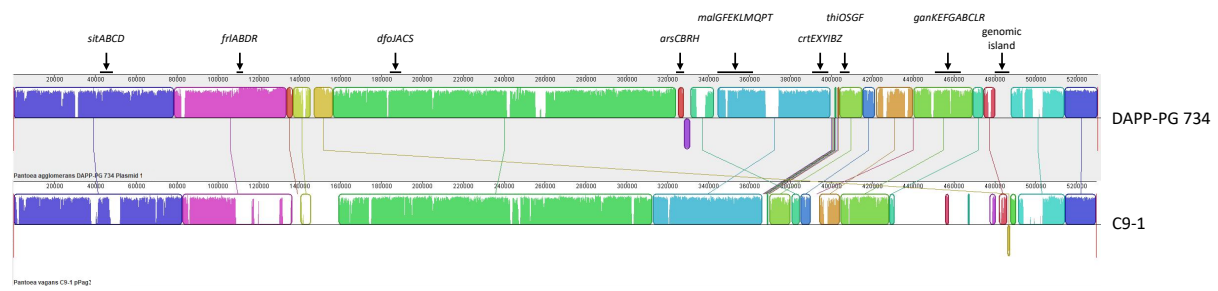


Figure S3: MAUVE alignment of *Pantoea agglomerans* DAPP-PG 734 plasmid 3 and *Pantoea vagans* C9-1 pPag1. Gene cluster for metabolic purpose and different features are indicated.

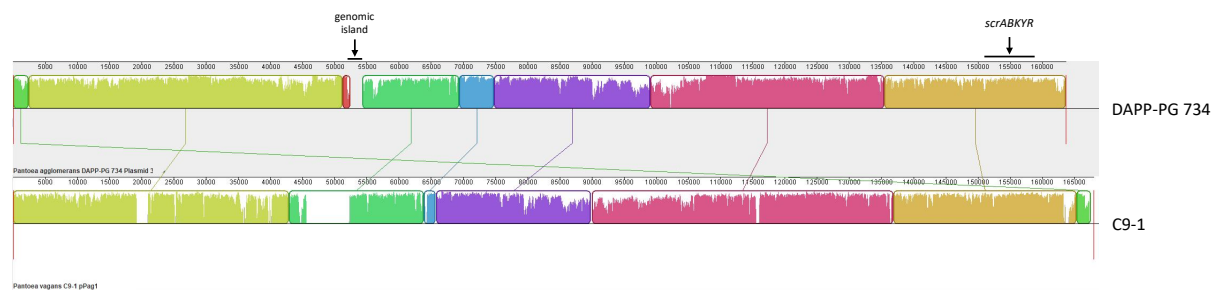


Figure S4: Gene cluster for degradation of fructoselysine in five strains of *Pantoea agglomerans*. Identical gene clusters within the genomes are shaded in grey and homologous genes are marked in the same color. The *frlABDR* gene cluster is colored in red and the additional subunit is colored in orange. White arrows represent no similarity to genes of other strains.

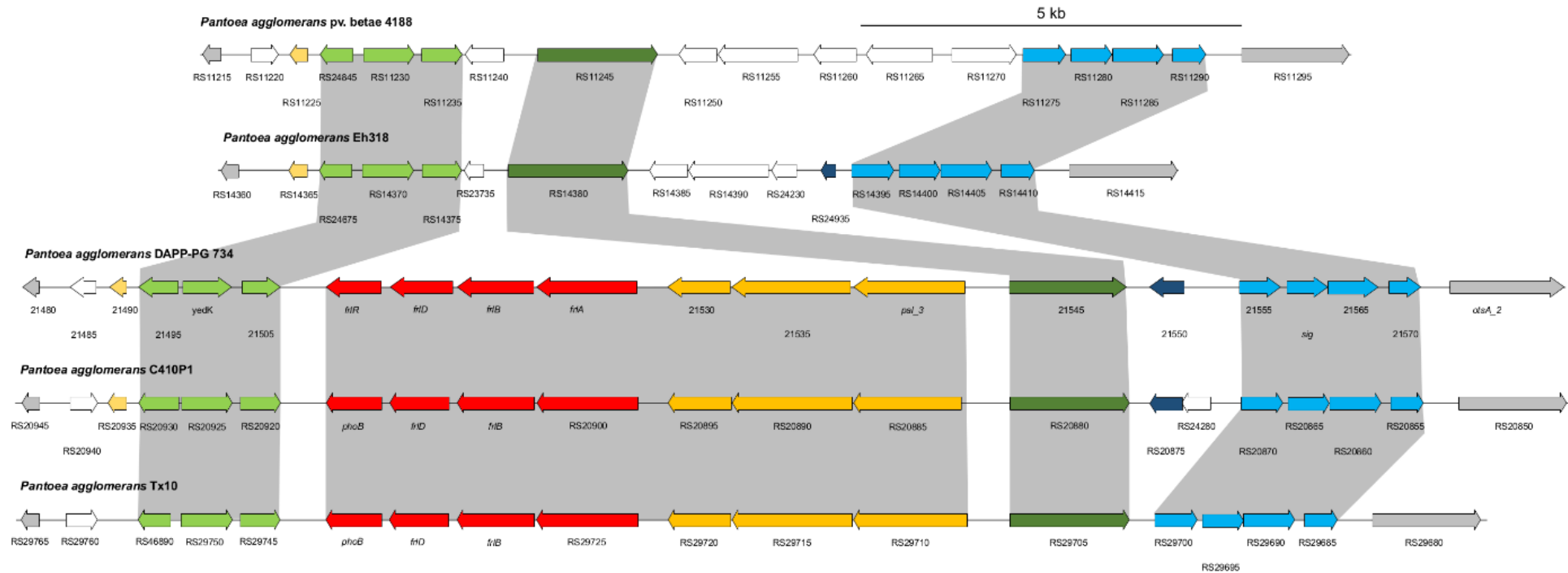


Figure S5: Gene cluster for biosynthesis of dapdiamide E in five *Pantoea* spp. The gene cluster for biosynthesis of dapdiamide E is shaded in grey, while the needed genes are colored in green. Conserved homologous genes, which are not part of the dapdiamide E cluster, are colored in yellow or in blue. White colored arrows represent no similarity to other genes. Pseudogenes are marked as dashed colored arrows.

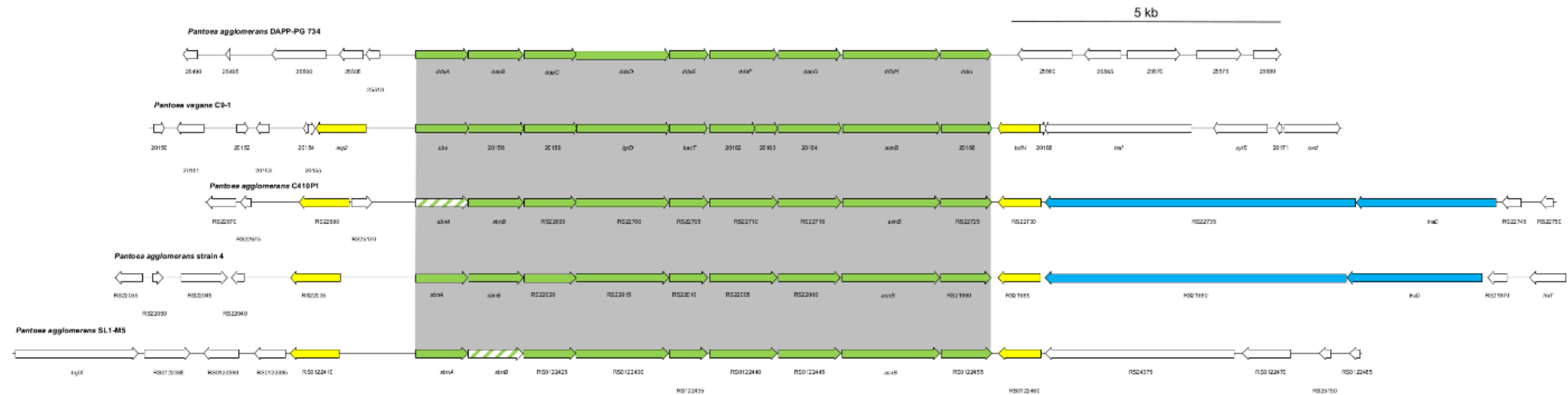


Figure S6: Gene cluster for biosynthesis of antibiotic B025670 in six *Pantoea* spp. The gene cluster for biosynthesis of antibiotic B025670 is shaded in grey, while the required genes are colored in violet. Homologous genes are marked in the same color. White colored arrows represent no similarity to other genes. A red asterisk represents a contig breaks within the sequenced genome.

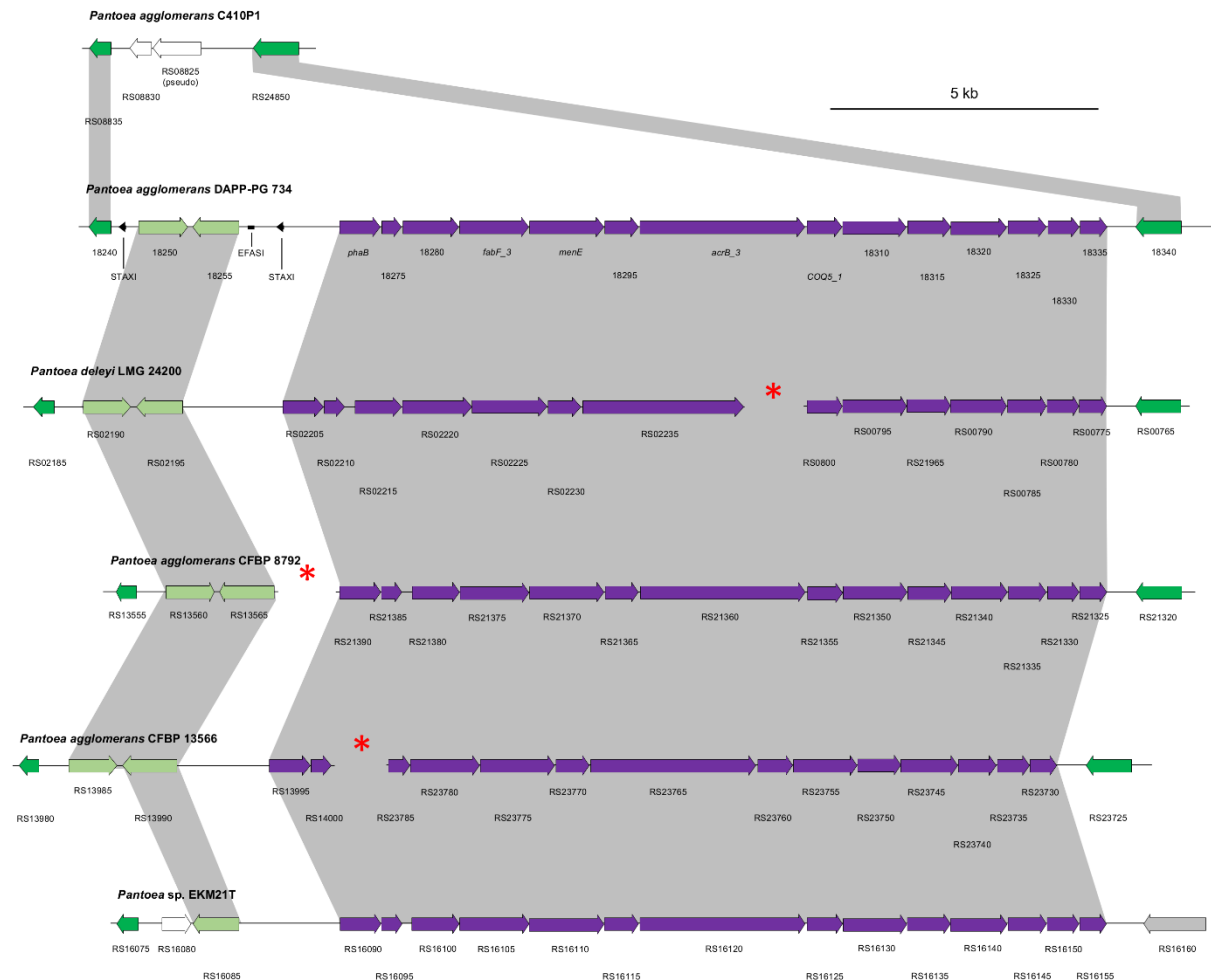


Figure S7: Gene cluster for type VI secretion system 1 (T6SS-1) in five *Pantoea* spp. The grey shadings show the conserved regions. Green marked arrows represent gene coding domains identified by Boyer et al. [17], and yellow painted arrows are not described genes by Boyer et al. [17] but are conserved genes among the *Pantoea* T6SS-1 loci [5]. The grey labelled arrows show the flanking sites of each strain. The red arrows stand for the *vgrG* and *hcp* genes. Blue- and light salmon-colored arrows represent homologous genes but are not part of the conserved region while the non-colored arrows (white) do not belong to the conserved genes and are not similar to other genes. Dashed colored arrows represent pseudogenes.

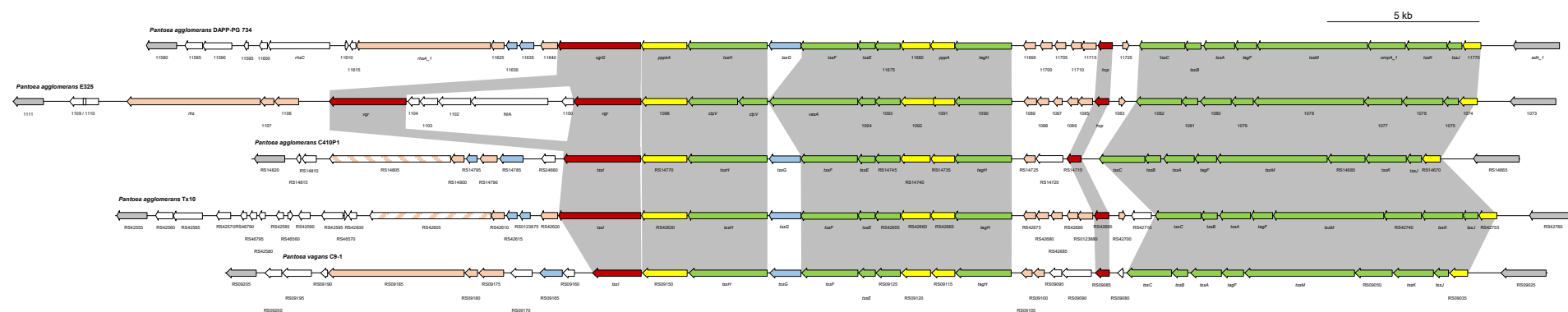


Figure S8: Gene cluster for type 6 secretion system 6 (T6SS-6) in five *Pantoea agglomerans*. This figure shows the genes involved for the biosynthesis of T6SS-6. The grey shading shows the identical cluster within the genome. Green marked arrows represent identical genes and grey labelled arrows shows the flanking sites of each strain. The red arrows identify the *vgrG* and *hcp* effector genes. Dashed colored arrows represent pseudogenes. 5 kb

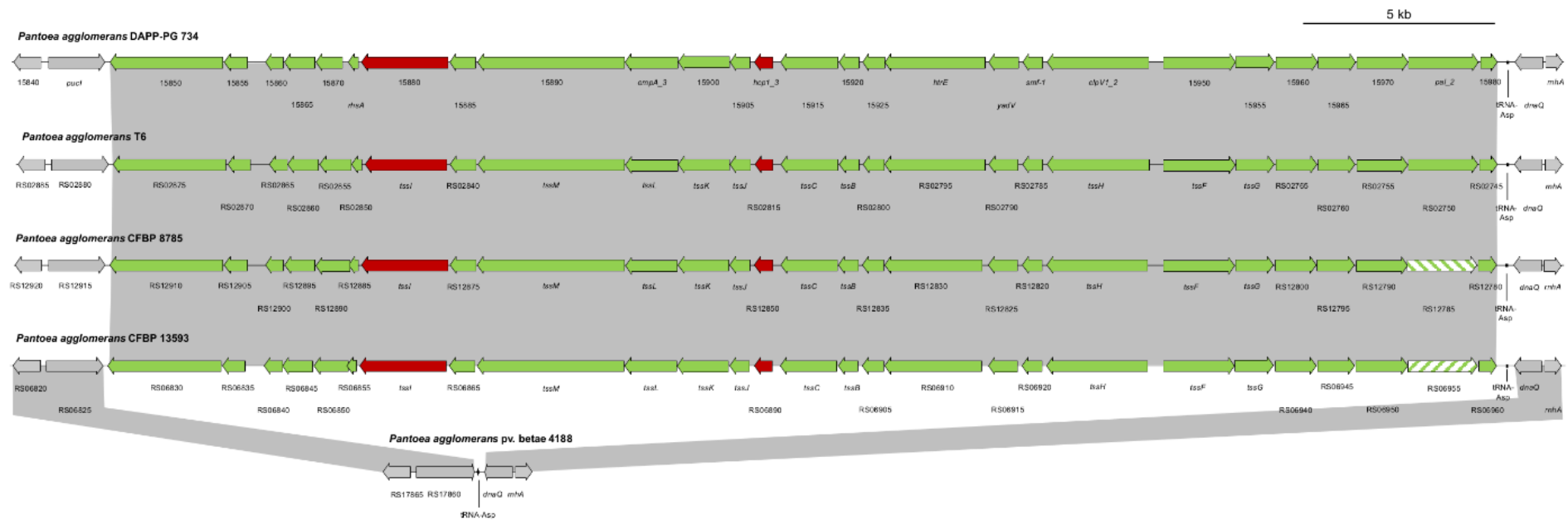


Figure S9: Gene cluster for biosynthesis of enterobactin in four *Pantoea* spp. The *ent-fep* gene cluster is shaded in grey, while the responsible genes are colored in green. Yellow colored arrows represent homologous genes but are not conserved genes. The flanking sequences are indicated by grey colored arrows.

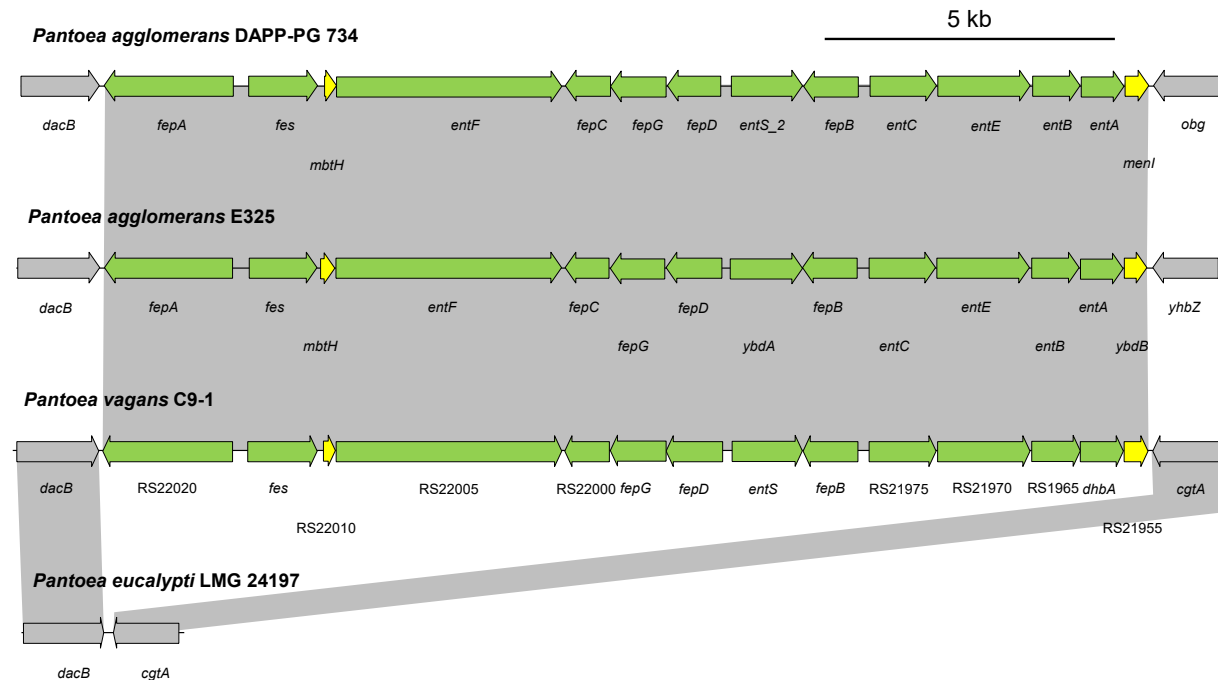


Figure S10: Gene cluster of the autoinducer biosynthesis *pagRI* in six *Pantoea* spp. The genes *pagRI* are colored in green and identical gene region within the genomes of related strains are shaded in grey. Blue and grey colored arrows represent homologous genes. Non-colored arrows (white) have no orthologs in the strains shown.

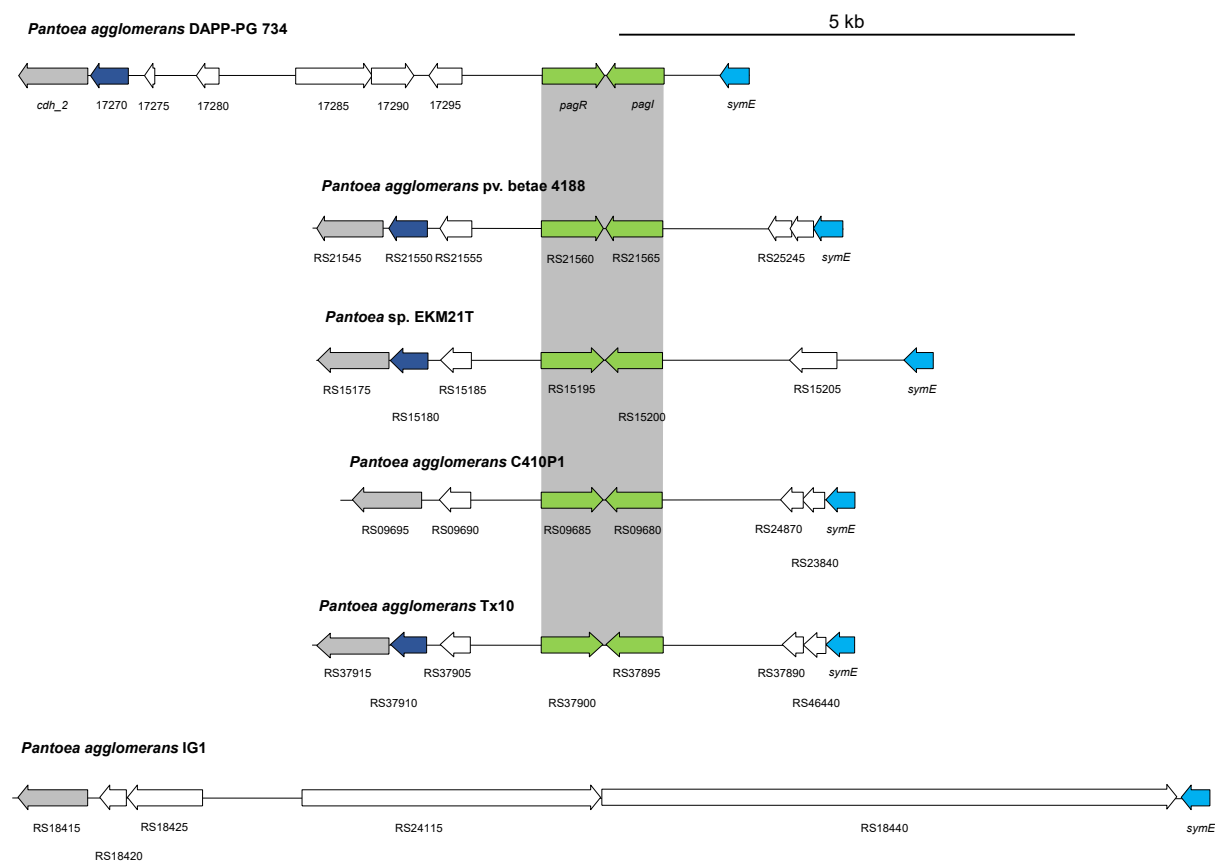
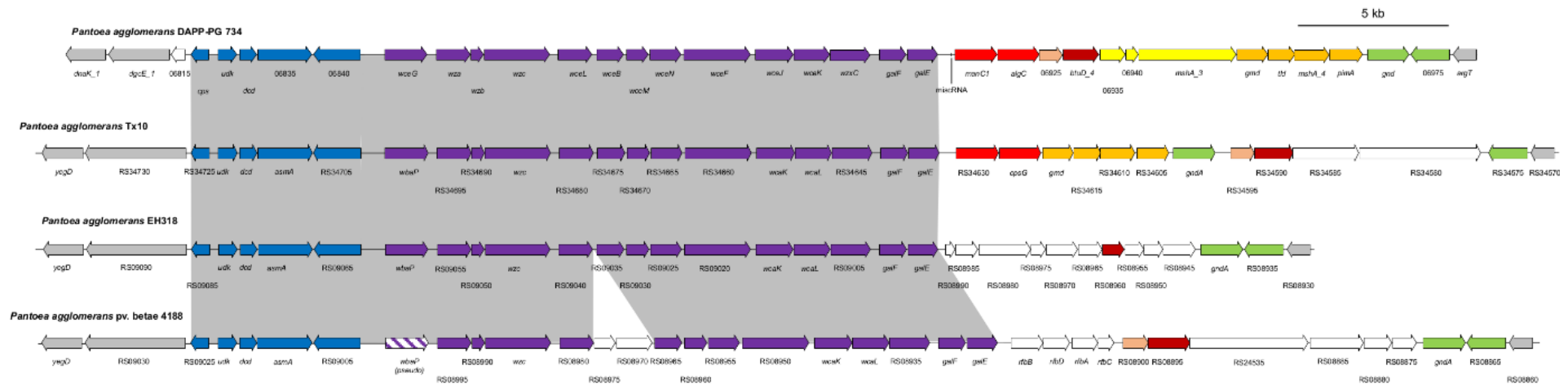


Figure S11: Gene cluster for biosynthesis of exopolysaccharide (EPS) in four *Pantoea agglomerans*. Identical genes within a genomic range across the compared strains are shaded in grey, while the responsible genes for the biosynthesis of EPS are colored in violet. Homologous genes, which are not part of the EPS cluster, are grouped by related colored arrows and pseudogenes are marked as dashed colored arrows. White arrows represent no similarity to genes in related strains.



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