Expression of flagellar and type III secretion systems is under stochastic and deterministic regulation in Pseudomonas syringae

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We previously described bistability and phenotypic heterogeneity of the type III secretion system (T3SS) of Pseudomonas syringae (Rufián et al., 2016). First example of such phenomenon in a plant pathogen. Here, we describe heterogenous flagellar expression leads to phenotypic heterogeneity within P. syringae populations. We find that although as reported flagellin is downregulated inside the plant, it is still expressed by a part of the bacterial population that maintains high expression levels during colonization of the plant apoplast. We demonstrate that expression of the T3SS and flagellar systems undergo counter regulation that is displayed at a single-cell level as T3SS^{ON}/Flagella^{OFF} and T3SS^{OFF}/Flagella^{ON} subpopulations. Despite this counter regulation, T3SS^{ON}/Flagella^{ON} and T3SS^{OFF}/Flagella^{OFF} bacteria can also be found within the apoplast at significant levels. Genetic analysis of the elements involved shows that counter-regulation is reciprocal: altered levels of T3SS transcriptional activator HrpL affect flagellar expression and altered levels of flagellar master regulator FleQ affect T3SS gene expression. But it also shows that the heterogeneity of each of these systems arises through independent mechanisms and display different dynamics. The regulatory loops involved in establishing T3SS and flagellar heterogeneity in P. syringae are different to those described for these systems in animal pathogen, suggesting convergent evolution of heterogeneity. Finally, we analyze the biological implications of heterogeneity and propose that, through a division of labor strategy, heterogeneity may provide adaptive value to this pathogen. This is one of the few examples where phenotypic heterogeneity is analyzed in natural conditions within the context of host colonization.

Comentado [CDRBL1]: Ver según revista (política y modo)