Division of Labor during Biofilm Matrix Production

Organisms as simple as bacteria can engage in complex collective actions, such as group motility and fruiting body formation. Some of these actions involve a division of labor, where phenotypically specialized clonal subpopulations or genetically distinct lineages cooperate with each other by performing complementary tasks. Here, we combine experimental and computational approaches to investigate potential benefits arising from division of labor during biofilm matrix production. We show that both phenotypic and genetic strategies for a division of labor can promote collective biofilm formation in the soil bacterium Bacillus subtilis. In this species, biofilm matrix consists of two major components, exopolysaccharides (EPSs) and TasA. We observed that clonal groups of B. subtilis phenotypically segregate into three subpopulations composed of matrix non-producers, EPS producers, and generalists, which produce both EPSs and TasA. This incomplete phenotypic specialization was outperformed by a genetic division of labor, where two mutants, engineered as specialists, complemented each other by exchanging EPSs and TasA. The relative fitness of the two mutants displayed a negative frequency dependence both in vitro and on plant roots, with strain frequency reaching a stable equilibrium at 30% TasA producers, corresponding exactly to the population composition where group productivity is maximized. Using individual-based modeling, we show that asymmetries in strain ratio can arise due to differences in the relative benefits that matrix compounds generate for the collective and that genetic division of labor can be favored when it breaks metabolic constraints associated with the simultaneous production of two matrix components. Microbes that live predominantly in complex biofilms often cooperate with each other by performing complementary tasks. Dragoš et al. use a plant-colonizing Bacillus subtilis model and combine experimental and computational approaches to demonstrate and rationalize benefits arising from genetic division of labor during biofilm matrix production.

General information
Publication status: Published
Organisations: Bacterial Interactions and Evolution, Department of Biotechnology and Biomedicine, Disease Systems Immunology, Friedrich Schiller University Jena, Max-Planck-Institute for Terrestrial Microbiology, University of Zurich
Corresponding author: Kovács, Á. T.
Pages: 1903-1913
Publication date: 2018
Peer-reviewed: Yes

Publication information
Journal: Current Biology
Volume: 28
Issue number: 12
ISSN (Print): 0960-9822
Ratings:
BFI (2018): BFI-level 2
Scopus rating (2018): CiteScore 5.39 SJR 3.968 SNIP 2.135
Web of Science (2018): Indexed yes
Original language: English
Electronic versions:
emss_80895.pdf. Embargo ended: 18/06/2019
DOIs:
10.1016/j.cub.2018.04.046
Source: FindIt
Source-ID: 2435345839
Research output: Contribution to journal › Journal article – Annual report year: 2018 › Research › peer-review