
Phage-plasmids are prevalent and produce antibiotic resistant lysogens

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Abstract

Plasmids are DNA molecules that replicate autonomously within cells and are usually thought to transfer by conjugation. In the literature they are very clearly distinguished from prophages of temperate phages, which are usually described as integrating the host chromosome. Some elements, termed phage-plasmids, blur these definitions by infecting bacteria as phages and replicating as plasmids. However, their number, diversity, and contribution to bacterial phenotypes remained poorly known.

To study phage-plasmids, we first developed a screen to detect them in bacterial genomes, plasmid and phage databases. Strikingly, we found phage-plasmids to be numerous and prevalent (5% of > 25k phages/plasmids) in Prokaryotes. We computed and used the gene repertoire relatedness to classed them into different groups. Interestingly, most groups are not related, suggesting independent origins. Nevertheless, all elements have typical phage and plasmid features, suggesting that phage-plasmids are diverse and ancient (1). Phages rarely encode antibiotic resistance genes (ARGs) whereas plasmids often do. What about phage-plasmids which have mixed features of both types of elements? We find that ARGs are 80 times more frequent in phage-plasmids than in phages and 5 times less than in plasmids. Phage-plasmids transfer as phages. Could they spread ARGs as viruses? To test this, we isolated phage-plasmids from Carbapenem-resistant enterobacterial strains that were retrieved from clinical samples and conducted induction and infections experiments. We confirmed that phage-plasmids of different types, and encoding different ARG classes, are inducible by mitomycin C and generate antibiotic resistant lysogens after infection (2).

In conclusion, our results show that phage-plasmids are abundant elements are capable of transferring accessory genes typical of phages and of plasmids. This point out, that they may have a remarkable impact on bacterial evolution.

(1) E Pfeifer, JA de Sousa, M Touchon, EPC Rocha, 2021, NAR, doi: 10.1093/nar/gkab064

(2) E Pfeifer, R Bonnin, EPC Rocha, 2022, bioRxiv, <https://doi.org/10.1101/2022.06.24.497495>

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