BIOFILM FORMATION AND BACTERIOCINOGENY AS MANIFESTATIONS OF BACTERIAL STIGMERGY

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The term «stigmergy» was introduced by French entomologist Pierre-Paul Grasse to describe the behavior of termites during the construction of termite colonies. The principle of stigmergy describes self-organized phenomena that arise as a result of mediated communication between individuals in a group through the generation of constant signals to the external environment [4]. However, the application of the concept of stigmergy to describe the collective behaviour of bacteria has only recently been proposed.

A special form of stigmergy is the ability of microorganisms to form biofilms [5]. Biofilm formation is determined by adaptive reactions to the influence of external environmental conditions and consists in the ability of bacteria to synthesize a number of protective substances and virulence factors in response to environmental signals [3]. Bacteria in biofilm forms are able not only to protect themselves from the effects of adverse environmental factors, but also to secrete a number of substances that help them to colonize certain econiches and actively compete with other microorganisms. Bacteriocins can be classified as such substances. Bacteriocins are analogues of antibiotics, they are synthesized by most microorganisms and have a narrow spectrum of action, which is directed at representatives of related taxa [2]. Thus, *Pseudomonas aeruginosa* bacteriocins (S5 pyocins) are able to inhibit the growth of phytopathogenic strains of *Pseudomonas syringae*. Bacteria can synthesize several types of bacteriocins. For *P. aeruginosa*, for example, it has been described the production of high molecular weight structures - analogues of phage tail, low molecular weight proteins, and microcin-II-like bacteriocins. Moreover, bacteriocins of different types can combine with each other, which leads to their stabilization and enhanced antimicrobial activity [1]. It has been shown that producer cultures are capable of isolating bacteriocins with varying intensity depending on the cultivation temperature. Thus, microorganisms isolated from soil synthesize substances more actively at 28 °C, while clinical isolates - at 37 °C. However, a slight increase in temperature to 30-40°C has a stimulating effect on the intensity of bacteriocin production by soil isolates, increasing their activity up to 16 times. When added to poor culture medium, bacterial cells in biofilm do not synthesize bacteriocins, as the main emphasis in this case is on protecting of population through enhanced biofilm formation. These cultivation conditions should obviously be considered as a stress factor for producer cells, which necessitates the intensification of the struggle for survival. Thus, biofilm formation and bacteriocinogeny can be regarded as interrelated bacterial survival strategies.

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