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Instability of waves formed by motile bacteria

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Abstract: Many motile chemotactic bacteria (for instance, *Escherichia coli*) inoculated at some point in a semisolid nutrient medium can form circular expanding population waves. The formation of these motile structures is due to chemotaxis. The circular waves originate from an expanding bacterial lawn (a parent population). The regular shape of these waves results from the isotropic distribution of freely diffusible nutrient molecules which are also attractants. In this paper we show that the regular shape of the bacterial population waves can be spontaneously disturbed. As this takes place arc-shaped population waves ('bursts') are formed. It was found that initially the mean length of the cells forming the bursts was greater than that of the parent cell population. But then it decreased resulting in a value characteristic of the parent population.

Key words: *Escherichia coli*; Motility; Population waves; Stability

Introduction

On a semisolid nutrient medium many expanding bacterial populations can form population waves characterized by an increased density of microorganisms (Fig. 1a). The formation of these waves is due to the ability of bacteria to accumulate (through chemotaxis) in the regions with higher attractant concentration [1]. This process takes some time. Just after inoculation the bacteria form an expanding bacterial lawn (a parent population) [2]. Then one or two, or even three bacterial rings (population waves) flake off (see, for example, Fig. 1a, where two circular waves, formed by *E. coli*, are seen).

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In the present paper we report on the stability of the shape of these waves. We show that the regular shape of the bacterial population waves can be spontaneously disturbed.

Materials and Methods

To form expanding bacterial population waves, we inoculated bacteria (*Escherichia coli*, strain C, see [3]) at a point on agar nutrient medium (as in [4]) containing peptone (1%, w/v) and NaCl (0.5% w/v). The agar content was (0.28–0.4)%. The medium was poured into Petri dishes to about 3 mm thickness. After the inoculation the Petri dishes were incubated at 36 ± 0.1°C. The spatial structures were then photographed.

To obtain the two-dimensional map of optical density distribution (Fig. 2) we used a computer-