Accepted Manuscript

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PII: S0893-9659(17)30315-4
DOI: https://doi.org/10.1016/j.aml.2017.10.006
Reference: AML 5351

To appear in: *Applied Mathematics Letters*

Received date : 12 September 2017
Accepted date : 14 October 2017

Please cite this article as: H. Li, Y. Tao, Boundedness in a chemotaxis system with indirect signal production and generalized logistic source, Appl. Math. Lett. (2017), https://doi.org/10.1016/j.aml.2017.10.006

Boundedness in a chemotaxis system with indirect signal production and generalized logistic source

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Abstract

This work considers the chemotaxis-growth system

$$\begin{cases} u_t = \Delta u - \nabla \cdot (u \nabla v) + u - u^\alpha, \\ v_t = \Delta v - v + w, \\ w_t = u - \delta w, \end{cases}$$

in a smoothly bounded domain $\Omega \subset \mathbb{R}^n$, $n \geq 2$, with zero-flux boundary conditions, where $\delta > 0$ and $\alpha > 1$ are given positive parameters.

In the case when $n = 3$ and $\alpha = 2$, the global existence and boundedness of smooth solutions to this system was previously asserted in [6]. Inspired by an approach newly developed in [13], the present work improves the aforementioned result to a general case when $n \geq 2$ and $\alpha > \frac{n}{2}$.

Key words: chemotaxis, indirect signal, generalized logistic growth, boundedness
AMS Classification: 35B45, 35K57, 35Q92, 92C17

1 Introduction

Chemotaxis refers to a directed migration of cells in response to concentration gradients of a chemical substance, and the prototypical chemotaxis system was originally proposed by Keller and Segel ([7]). The Keller-Segel (abbreviated as KS henceforth) system and its variants have been extensively studied (see the surveys [4, 1, 17], for instance). An important feature of the KS system is the spontaneous singularity formation for large sets of initial data in high dimensional cases ([3, 16]).

In the classical KS system, the chemotactic signal is produced directly by cells themselves. However, in some realistic biological processes the signal generation undergos intermediate stages, and such indirect signal production mechanisms may delay or prevent the afore-said spontaneous singularity formation (cf. [11, 2, 6, 14], for instance).

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