

**PERMANENCE FOR NONAUTONOMOUS
N-SPECIES LOTKA-VOLTERRA COMPETITIVE
SYSTEMS WITH FEEDBACK CONTROLS**

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ABSTRACT. In this paper, the permanence of nonautonomous n -species Lotka-Volterra competitive systems with feedback controls is studied. Some new criteria on the permanence for all positive solutions are established. The corresponding results given by Chen in [3] are improved.

1. Introduction. As we know, ecosystems in the real world are continuously disturbed by unpredictable forces which can result in changes in biological parameters such as survival rates. Of practical interest in the ecosystem is the question of whether or not an ecosystem can withstand those unpredictable forces which persist for a finite period of time. In the language of control variables, we call the disturbance functions *control variables*.

In recent years, population dynamic systems with feedback controls have been studied in many articles, for example, see [2–6, 9–12] and references cited therein. Some important subjects such as persistence, permanence, global asymptotic stability and the existence of positive periodic solutions and positive almost periodic solutions, etc., are extensively investigated.

In [3], the author proposed the following n -species nonautonomous Lotka-Volterra competition system with feedback controls

$$(1) \quad \begin{aligned} x'_i(t) &= x_i(t)(b_i(t) - \sum_{j=1}^n a_{ij}(t)x_j(t) - d_i(t)u_i(t)), \\ u'_i(t) &= r_i(t) - e_i(t)u_i(t) + f_i(t)x_i(t), \quad i = 1, 2, \dots, n. \end{aligned}$$

2000 AMS *Mathematics subject classification*. Primary 34D25, 92D25.

Keywords and phrases. Permanence, competition, nonautonomous Lotka-Volterra system, feedback control.

Supported by the National Natural Science Foundation of P.R. China (60764003), the Major Project of the Ministry of Education of P.R. China (207130) and the Scientific Research Programmes of Colleges in Xinjiang (XJEDU2007G01, XJEDU2006I05).

Received by the editors on August 22, 2007, and in revised form on January 12, 2008.

DOI:10.1216/RMJ-2008-38-5-1355 Copyright ©2008 Rocky Mountain Mathematics Consortium