Nonlinear Dynamics and Systems Theory, **24** (6) (2024) 582–593

Inducing Chaos through Timescales in a Three-Species Food Chain Model

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Received: April 1, 2024; Revised: November 2, 2024

Abstract: Over time, considerable attention has been devoted to understanding the complex dynamics of simplified ecosystems containing three trophic levels, revealing that complex behaviors can arise from a simple hierarchy between prey, predator, and top predator. In this study, the extension of a three-species food chain model with a Crowley-Martin-type functional response was examined by introducing discrete timescales to study its impact on system dynamics at various trophic levels. Changes in species abundance were analyzed across three different timescales: slow, fast, and intermediate. The presence of a homoclinic orbit in the subsystem (prey-predator) suggests the existence of period-doubling cascades that eventually lead to chaos in the entire system (prey-predator-top-predator). This study underscores the importance of ecological modeling and trophic interactions in understanding the diverse and intricate dynamics of ecosystems, thus highlighting the significance of research in this domain.

Keywords: *three-level trophic systems; time scales; chaos.*

Mathematics Subject Classification (2010): 37D45, 34C15, 37C75, 65L07, 70Kxx.

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