On The Stability of An Ammensal- Enemy Harvested Species Pair With Limited Resources

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Abstract

In this paper we intend to introduce a mathematical model of an Ammensal-enemy harvested species pair with limited resources . Both the Ammensal and enemy with limited resources are harvested at a constant rate. The model is characterized by couple of first order non-linear ordinary differential equations. All nine equilibrium points for this model are identified and their stability criteria are discussed.

1   Introduction

Mathematical modeling is an important interdisciplinary activity which involves the study of some aspects of diverse disciplines. Biology, Epidemiodology, Physiology, Ecology, Immunology, Bio-economics, Genetics, Pharmocokinetics are some of those disciplines. This mathematical modeling has raised to the zenith in recent years and spread to all branches of life and drew the attention of every one. Mathematical modeling of ecosystems was initiated in 1925 by Lotka [11]. The general concepts of modeling have been presented in the treatises of Meyer [12], Paul Colinvaux [13],

Kapur [7,8]. The ecological symbiosis can be broadly classified as Prey-predation, Competition, Mutualism, Commensalism, Ammensalism, and so on. N.C. Srinivas [15] studied the competitive ecosystems of two species and three species with limited and unlimited resources. Lakshminarayan and Pattabhiramacharyulu [9, 10] investigated Prey-predator Ecological models with a partial cover for the prey and alternate food for the predator. Recently, stability analysis of competitive species was carried out by Archana Reddy, Pattabhi Rama chryulu and Gandhi [5] and by Bhaskara Rama Sarma and Pattabhiramacharyulu [6], while the mutualism between two species was examined by Ravindra Reddy [14].Following this Phanikumar,Seshagirirao and Pattabhiramacharyulu [13] studied the commensalism of two species with limited resources. The present authors Acharyulu [1,2,3,4] and Pattabhi Ramacharyulu obtained some fruitful results "on the stability of an enemy-Ammensal species pair with limited resources"

Amensalism between two species involves one impeding or restricting the success of the other while the other species has no effect on it. It is a type of symbiosis. The present investigation is related to an analytical study of a two species Ammensal – enemy model. Both the Ammensal and enemy with limited resources are harvested at a constant rate. The model is characterized by a couple of first order non-linear ordinary differential equations. All nine equilibrium points for the model are obtained and their stability criteria are discussed. The linearised perturbed equations are solved and the trajectories are derived.

2   Notation Adopted

3.   Basic Equations

4   Stability of Equilibrium States

4.1 Equilibrium State E_1 :

4.2 Equilibrium state E_2 :

4.3 Equilibrium state E_3 :

4.4 Equilibrium State E_4 :

4.5 Equilibrium State E_5 :

4.6 Equilibrium State E_6:

4.7 Equilibrium State E_7 :

4.8 Equilibrium State E_8 :

4.9 Equilibrium state E_9 :

5 Open Problems

In the present paper we have investigated an Ammensal- enemy harvested species pair with limited resources.

i)   There is a scope to study the model where harvesting rate is proportional to the population sizes of the species with various resources.

ii) One can apply the concept of harvesting rate for a three species ecosystem.

iii) One can construct a cover for the Ammensal to protect it from the attacks of enemy and build up Lypunov's function to examine the global stability of this model.

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