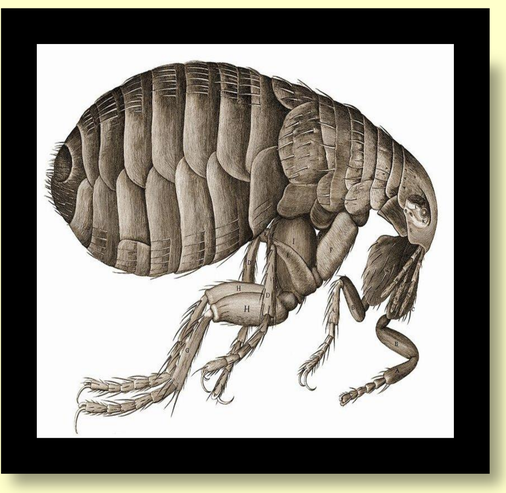
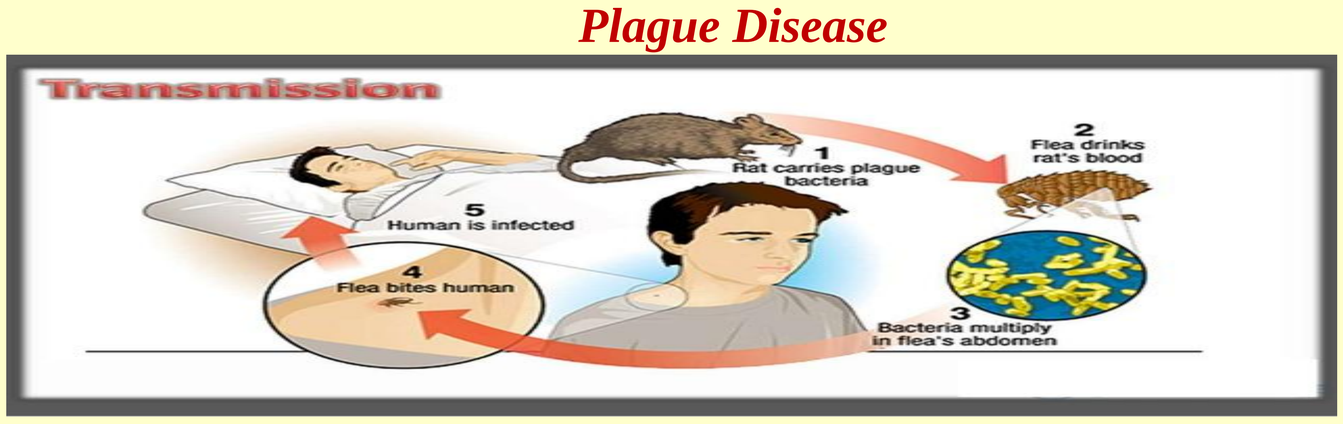
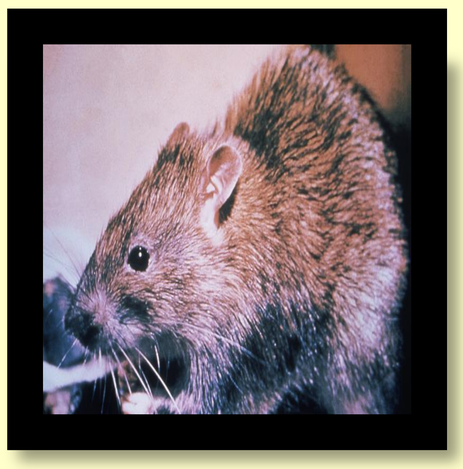
SEASONAL WEATHER VARIATIONS AND THE DYNAMICS OF INFECTIOUS DISEASES

Plague Disease







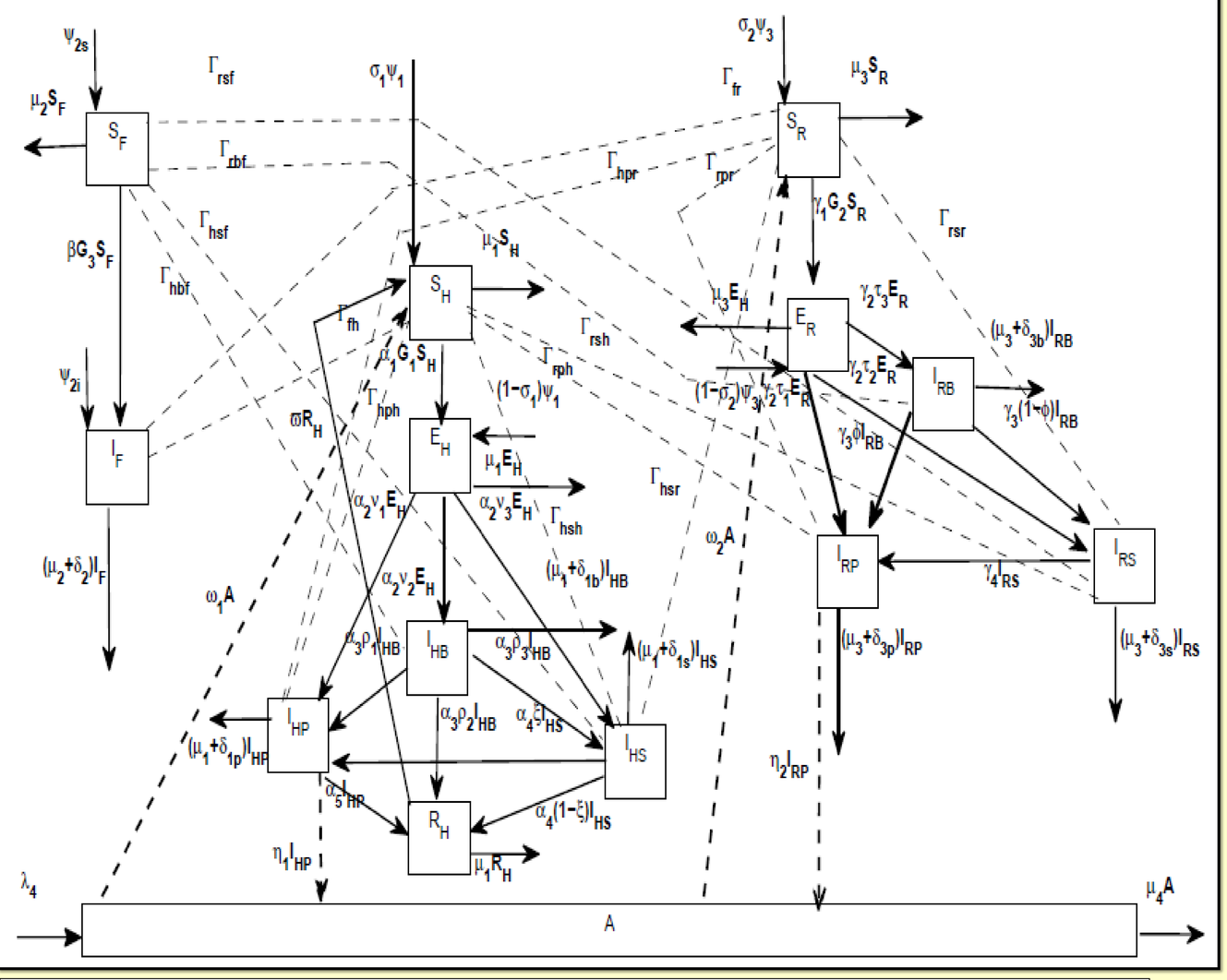
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Key words: Plague Disease, Weather Variation, Pathogens in the Environment, Periodic Solutions

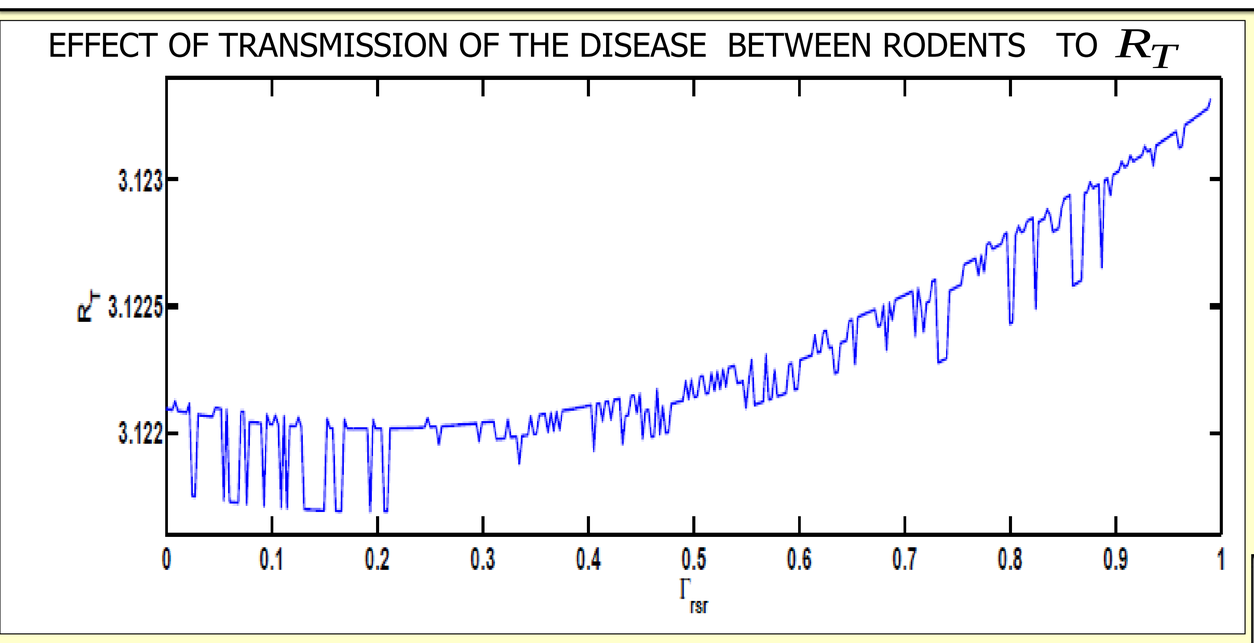
ABSTRACT

A mathematical model to study the effect of seasonal weather variation on the dynamics of plague disease is developed and analyzed. Using ordinary differential equations, we formulate a model for the dynamics of plague disease in four settings namely: Human beings, Rodents, Fleas and Pathogens in the environment. We found that the variation in number of plague disease cases mainly depend on: the transmission rate of infection from one individual to another; the incubation period of an individual and the time that an individual remains infectious. The analysis further reveals that the effects posed by seasonal weather variation depends on the extent to which the weather variation favours the transmission of plague disease (amplitude of seasonality) and the duration that it remains in favour of the increase or decrease of the rate of disease transmission and spread. Therefore the control strategies should target these factors and parameters that according to our results stated above have shown to have a significant effect on the dynamics of plague disease. We thus recommend the provision of education on plague disease infection, transmission and spread to raise people's awareness, continuous monitoring of factors that may lead to plague outbreak, easy access of plague disease treatment for all and the strong collaboration with neighboring countries on health related issues.

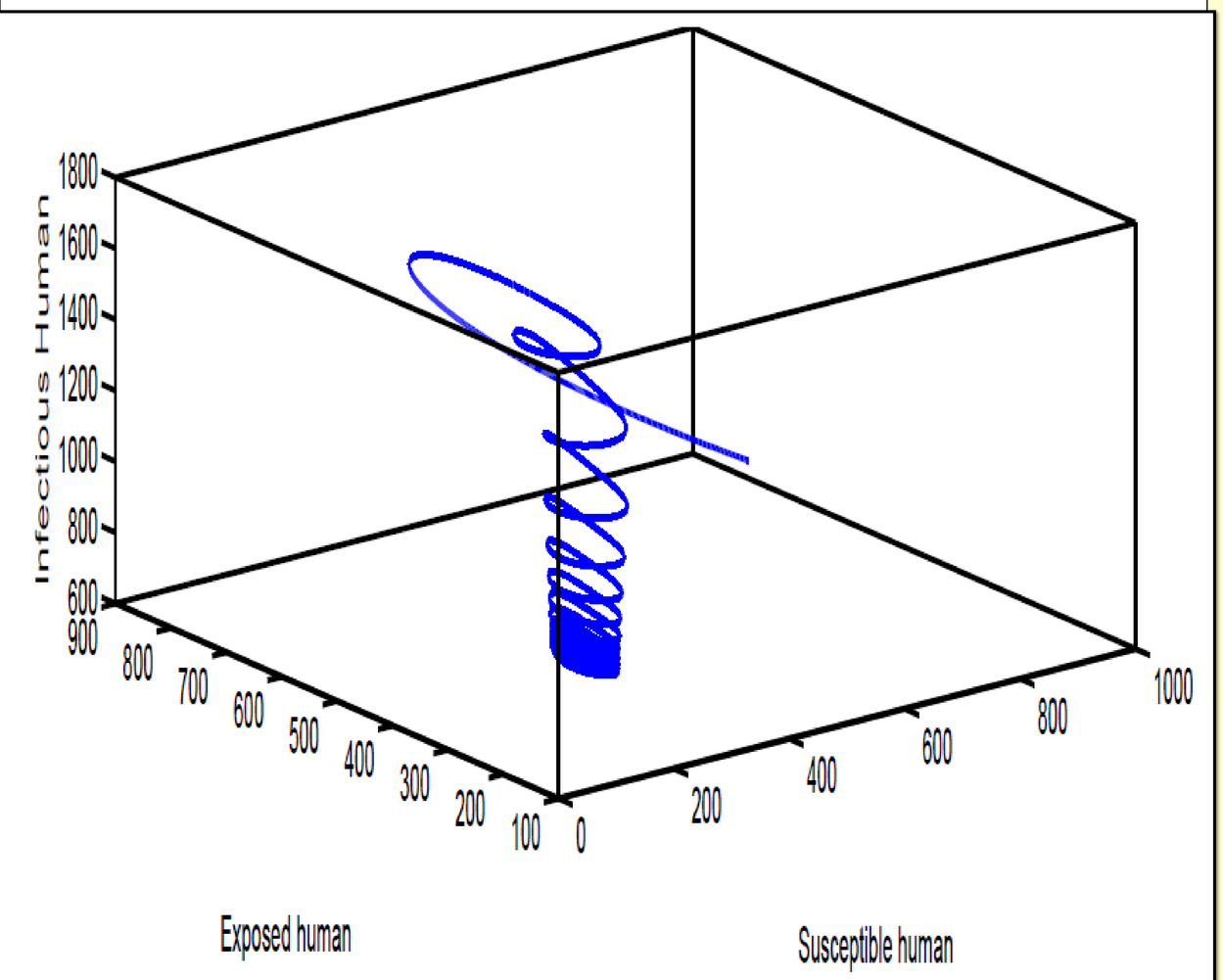
COMPARTMENTAL DIAGRAM



EFFECT OF TRANSMISSION OF THE DISEASE BETWEEN RODENTS TO R_T



DYNAMICS IN HUMAN POPULATION



INTRODUCTION

Plague is a zoonotic infection and serious bacterial disease that can be deadly. The disease is caused by bacteria called \textit{Yersinia pestis} a pleomorphic, gram-negative non-spore-forming coccobacillus that is more accurately classified as a subspecies of Y pseudotuberculosis, named after the French-Swiss bacteriologist Alexandre Yersin. Different studies have been carried out with the aim of understanding the plague disease in terms of the factors that led to the occurrence of the disease and its dynamics. The aim is to develop proper ways of controlling and overcoming the epidemic when it occurs. However, most of them did not consider the enzootic cycles in non-human hosts, and for those that did they assumed non-human hosts as being incapable of transmitting plague disease. Most studies consider non-human hosts as a reservoir of the Yersinia pestis that will be taken to human beings through a vector flea. Moreover, although most of the parameters that dictate the transmission and spread of plague disease are affected by seasonal weather variation, available studies have not exhaustively analyzed mathematically the effect of seasonal weather variation in the dynamics of plague disease.

In this study, we explore the mathematical modeling of the dynamics of the plague infections. We consider human host, non-human host and environment as plague disease transmission agents. We consider possible ways/modes of transmission of plague disease which are mainly direct physical contact, vector borne transmission, airborne transmission and indirect contact with respect to the features of the form of plague disease one has. We also extend our study to cover the effect of the parameters that may be affected by seasonal weather variation on the dynamics of the plague disease. We then develop a generic plague model (the model that combine all three forms of plague disease) that considers all factors that enable plague disease transmission including that of seasonal weather variation in order to extensively understand the dynamic of plague disease. We analyze the model to explain the conditions for existence, persistent and extinction of the disease, the stability and existence of positive periodic solution, disease-free equilibrium and the system's behavior through numerical simulation.

GENERAL OBJECTIVE

The main objective of this study was to develop a fully bodied mathematical models to study the dynamics of plague disease, and asses the effect of seasonal weather variations on its transmission.

SPECIFIC OBJECTIVES

1. To formulate and analyze basic mathematical models for bubonic plague dynamics and explore its behavior using numerical simulations
2. To formulate and analyze basic mathematical models for pneumonic plague dynamics and explore its behavior using numerical simulations.
3. To formulate and analyze the basic combined deterministic mathematical model for the dynamics of plague disease that will include all three forms of plague disease and all major ways/modes of plague disease transmission
4. To formulate and analyze the plague disease model incorporating with parameters that are affected by seasonal weather variation.

MODEL EQUATION FOR HUMAN BEINGS

$$\frac{dS_H}{dt} = \psi_1 + \varpi R_H - \alpha_1 G_1(t) S_H - \mu_1 S_H,$$
$$\frac{dE_H}{dt} = \alpha_1 G_1(t) S_H - \alpha_2 E_H - \mu_1 E_H,$$
$$\frac{dI_{HB}}{dt} = \alpha_2 \nu_2 E_H - \alpha_3 I_{HB} - (\mu_1 + \delta_{1b}) I_{HB},$$
$$\frac{dI_{HS}}{dt} = \alpha_3 \rho_3 I_{HB} + \alpha_2 \nu_3 E_H - \alpha_4 I_{HS} - (\mu_1 + \delta_{1s}) I_{HS},$$
$$\frac{dI_{HP}}{dt} = \alpha_2 \nu_1 E_H + \alpha_3 \rho_1 I_{HB} + \alpha_4 \xi I_{HS} - \alpha_5 I_{HP} - (\mu_1 + \delta_{1p}) I_{HP},$$
$$\frac{dR_H}{dt} = \alpha_3 \rho_2 I_{HB} + \alpha_4 (1 - \xi) I_{HS} + \alpha_5 I_{HP} - \varpi R_H - \mu_1 R_H.$$

PLAGUE INTRODUCTION AND SPREAD IN TANZANIA

