Exploring the Dynamics of Forest Biodiversity: Perspectives from a Four-Species Disease–Food Web Model

MEGALA T[1], SIVA PRADEEP M[1], NANDHA GOPAL T[1], YASOTHA A[2], AASAITHAMBI T[3]
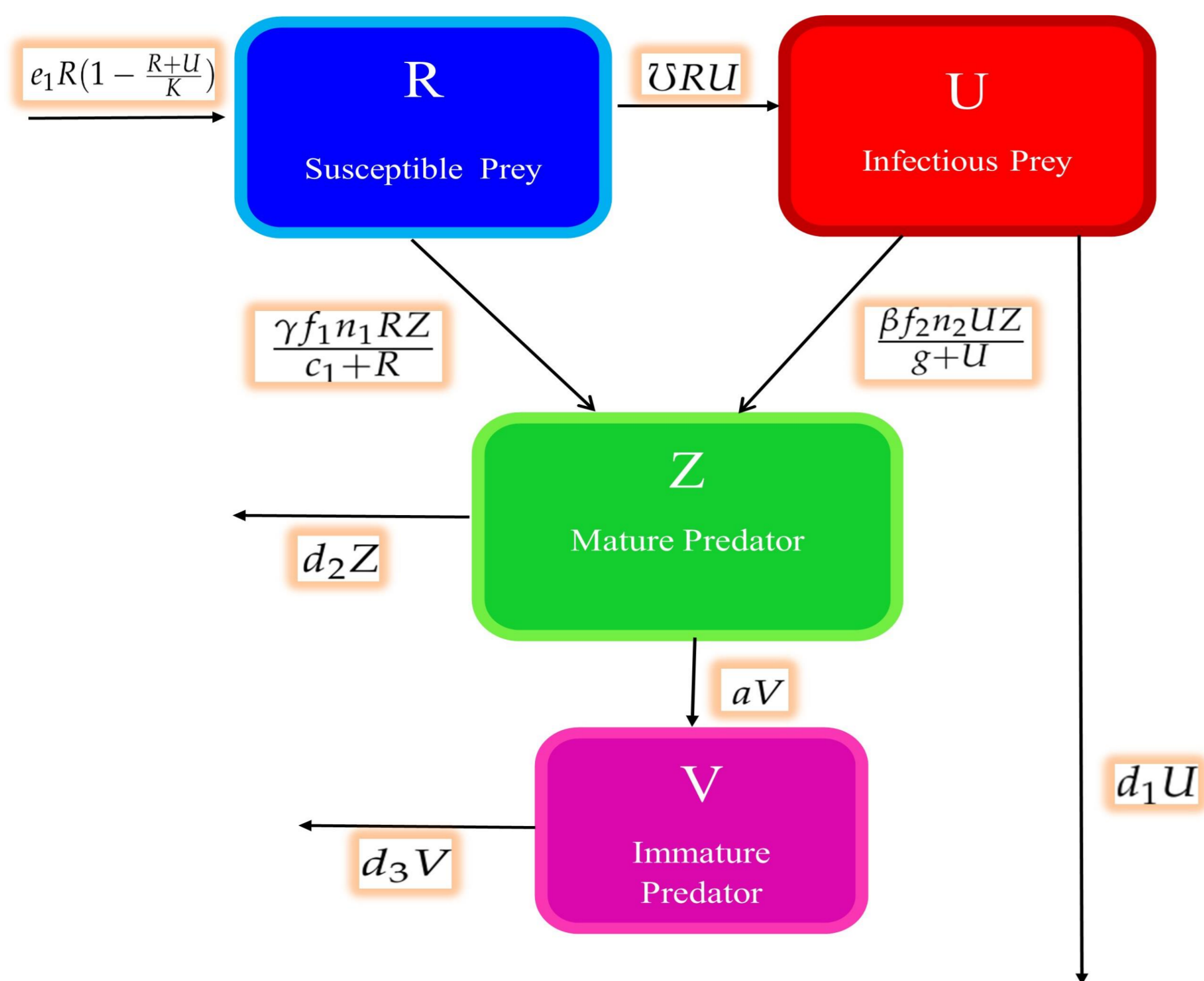
[1]SRI RAMAKRISHNA MISSION VIDYALAYA COLLEGE OF ARTS AND SCIENCE, COIMBATORE - 641 020, INDIA.
[2]UNITED INSTITUTE OF TECHNOLOGY, COIMBATORE - 641 020, INDIA.
[3]SRI SHANMUGHA COLLEGE OF ENGINEERING AND TECHNOLOGY, SALEM, INDIA.

INTRODUCTION & AIM

Forests are essential to Earth's ecosystems, supporting biodiversity and ecological balance. The dynamics of these ecosystems involve complex interactions among animals, fungi, and micro organisms. This study employs a prey-predator model with a Holling type II functional response to analyze how disease impacts predator-prey relationships within forest biodiversity.

MODEL EQUATION

$$\frac{dR}{dT} = e_1 R\left(1 - \frac{R+U}{K}\right) - \mho RU - \frac{\gamma RZ}{c_1+R},$$
$$\frac{dU}{dT} = \mho RU - \frac{\beta UZ}{g+U} - d_1 U,$$
$$\frac{dZ}{dT} = \frac{\gamma f_1 n_1 RZ}{c_1+R} + \frac{\beta f_2 n_2 UZ}{g+U} - aV - d_2 Z,$$
$$\frac{dV}{dT} = \frac{\gamma f_1 (1-n_1) RZ}{c_1+R} + \frac{\beta f_2 (1-n_2) UZ}{g+U} + aV - d_3 V.$$

NON-DIMENSIONAL EQUATION

$$\frac{dr}{dt} = r\left(1 - r - (1+y_1)u - \frac{y_2 z}{y_3+r}\right),$$
$$\frac{du}{dt} = u\left(y_1 r - \frac{y_4 z}{y_5+u} - y_6\right),$$
$$\frac{dz}{dt} = \frac{y_{11} rz}{y_3+r} + \frac{y_{12} uz}{y_5+u} + y_9 v - y_{13} z,$$
$$\frac{dv}{dt} = \frac{y_7 rz}{y_3+r} + \frac{y_8 uz}{y_5+u} - y_9 v - y_{10} v.$$

$$t = eT, \quad y_1 = \frac{\mho K}{e}, \quad y_2 = \frac{\gamma}{e}, \quad y_3 = \frac{c}{e}, \quad y_4 = \frac{\beta}{e}, \quad y_5 = \frac{g}{e}, \quad y_6 = \frac{d_1}{e},$$
$$y_7 = \frac{f_1\gamma(1-n_1)}{e}, \quad y_8 = \frac{f_2\beta(1-n_2)}{e}, \quad y_9 = \frac{a}{e}, \quad y_{10} = \frac{d_2}{e},$$
$$y_{11} = \frac{\gamma f_1 n_1}{e}, \quad y_{12} = \frac{\beta f_2 n_2}{e}, \quad y_{13} = \frac{d_3}{e},$$
$$r = \frac{R}{K}, \quad u = \frac{U}{K}, \quad z = \frac{Z}{K}, \quad v = \frac{V}{K}.$$

RESULTS & DISCUSSION

- The dynamical system of the equilibrium point $E_0(0,0,0,0)$ is unstable.
- The dynamical system of the equilibrium point $E_1(1,0,0,0)$, E_2, E_3, E_4, E^* is stable.

CONCLUSION

In this work, we investigated a four-species food web model in prey populations, in which a predator attacks both healthy and infected prey. Finally, this study aims to understand how changes in the environment can impact the dynamics of the ecosystem.

REFERENCES

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Population Dynamics Over Time