



# Some qualitative properties of the discrete models for malaria propagation

I. Faragó<sup>a,b,c,\*</sup>, R. Mosleh<sup>a,c</sup>

<sup>a</sup>Department of Differential Equations at Budapest University of Technology and Economics, Hungary

<sup>b</sup>Department of Applied Analysis and Computational Mathematics at Eötvös Loránd University, Hungary

<sup>c</sup>Numerical Analysis and Large Networks Research Group at ELKH-ELTE, Hungary



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## ABSTRACT

This paper addresses a reliable mathematical modeling of malaria propagation in infected societies for humans and mosquitoes with an extension of the basic Ross-Macdonald model. We analyze the extended Ross model numerically which is an initial value problem of a seven-dimensional system of the first-order ODEs. For this aim, the discretized scheme of the extended model is split into two parts. First, we apply the step-size functions to approximate the time derivatives with the first-order consistency. Then we use a nonlocal discretization of the standard  $\theta$ -method to the right side of the system to obtain a linear system. We find the conditions for the step-size functions under which specific intervals are positively invariant for the total populations and each component of the solution of the extended Ross model. We suggest a step-size function for the extended Ross model to preserve the dynamical consistency of the model for any step size  $\Delta t$ . The numerical simulations confirm the theoretical results for the examples and we compare the efficiency of the nonstandard Runge-Kutta methods with the different step-size functions for sufficiently large step sizes.

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## 1. Introduction

Nowadays that most people are struggling with COVID-19 pandemic throughout the world, there are other types of epidemics that human beings have been dealing with them for ages such as malaria which is an infectious and deadly disease spread to humans as hosts by female *Anopheles* mosquitoes as vectors. This phenomenon, which is endemic in tropical and subtropical regions ascertains greatly to the climate factors such as temperature, altitude, precipitation, and raised humidity. Moreover, global warming and climate change increase this incident. Other various reasons are responsible for the latest malaria upsurge, such as drug resistance, mosquito control programs, public health facilities, and living standards. Nevertheless, since there is no effective vaccine, it is crucial to analyze its mechanism [1,18,22].

Reliable mathematical modeling of epidemics transmission is a key tool for getting a better insight into the disease, prevent them from contagion in the future, and reduce their impacts in the real life. For this aim, a variety of mathematical models have been brought up to interpret malaria transmission. Ronald Ross was a pioneer in this field [21] and his model

\* Corresponding author.

E-mail address: [rmosleh028@gmail.com](mailto:rmosleh028@gmail.com) (R. Mosleh).

# Discrete Models Applied Mathematics And Computation

## No 3

**Sabine Zange**



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web sep 22 2023 strabismus is a condition where there is misalignment of the visual axes of the eyes it may be latent or manifest and if manifest it may be constant or intermittent it is a common cause of diplopia and visual confusion seeing different objects in the same place in adults it is an important

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web crossed eyes or strabismus is a condition in which both eyes do not look at the same place at the same time it usually occurs due to poor eye muscle control or farsightedness strabismus usually develops in infants and young children most often by age 3