Western Science

Department of Applied Mathematics

Applied Mathematics Colloquium

Date: Thursday, December 4, 2014
Time: 2:30 – 3:30 p.m.
Location: Middlesex College Room 204

Malaria dynamics in seasonal environment with long incubation period in hosts

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Abstract: The incubation period of malaria can vary depending on the species of parasite or the geographic regions. In particular, in endemic areas of temperate climate (for example in Korea), the incubation period of Plasmodium vivax shows bimodal distribution of short and long term incubation periods. Assuming fixed length for the long term incubation period (DDE) gives a distribution that is much closer to the empirical distribution than the exponentially distributed long term incubation period (ODE). We compare the two transmission models and identify the basic reproduction number R0 showing it is a threshold parameter for the global dynamics.While the qualitative behaviors of the two models are similar, the ODE model overestimates the basic reproduction number and also the level of endemicity, compared to the DDE model. By calculating R0, we can see that long incubation time is not beneficial to the parasite in a constant environment, thus its presence is connected to the seasonal mosquito activity in Korea. In contrast to the autonomous case, when we incorporate seasonality into our model equations, the interplay of the time delay and the periodicity results that in some situations the DDE model predicts higher prevalence of malaria. The periodic DDE model is also superior to periodic ODE in capturing the qualitative properties of the observed Korean malaria time series, while its mathematical analysis is rather challenging. Finally, we consider the evolution of the incubation time. Prolonged incubation time of P. vivax malaria in temperate region is considered to be an adaptation strategy to the seasonal environment. We present evolutionary models of the pathogen in a seasonal environment. Using theories of adaptive dynamics, we explore the direction of the evolution depending on mosquito season length, we show the possibility of the coexistence of short and long incubation times as strategies, and predict the change in the life-pattern of parasites along with climate change.