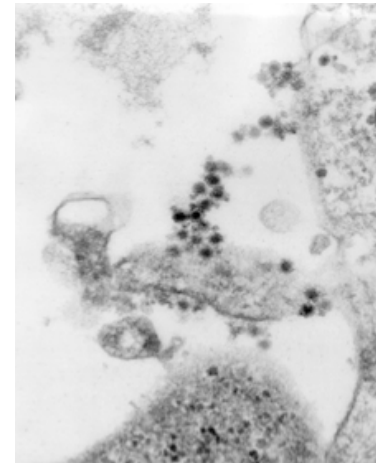
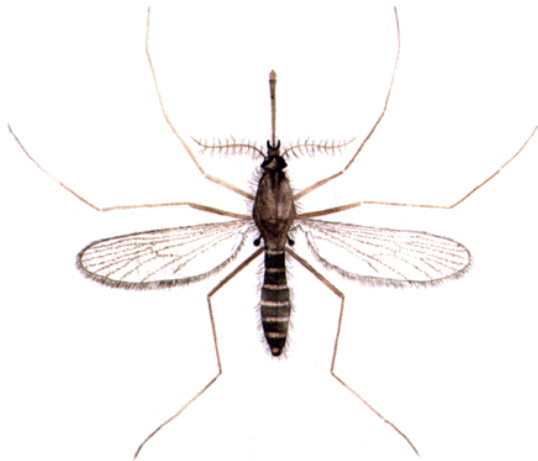


Underestimation of WNV?



Yi Ming Yu

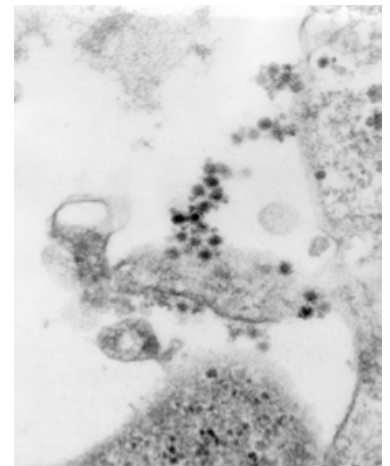
Mentor: Dr. Nina Fefferman and Ashley DeNegre

DIMACS, Rutgers University

Summer 2012

West Nile Disease

- Caused by a virus of a family of *Flaviviridae*.
- Vector-Borne disease transmitted by mosquitoes to humans and some animals.
- First identified in 1937 in eastern African and first discovered in the summer of New York in 1999.
- Since then, the virus has spread all over United States.



Ecologic Surveillance

Goal: predict and prevent human and domestic animal infections.

- Detection of WNV in dead bird and infected mosquito populations.

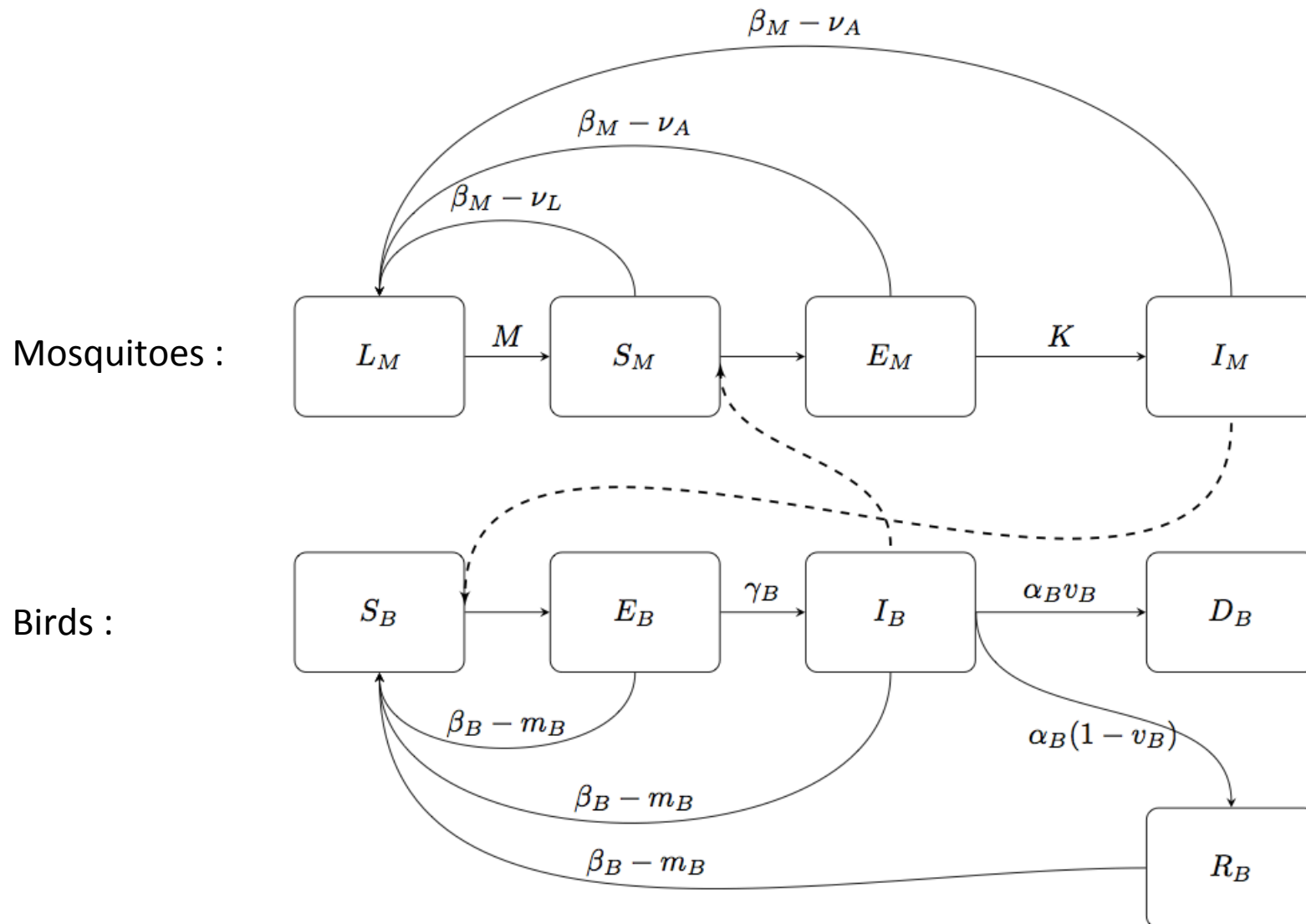
Failure of predictions

- Failure of sampling data
- Factor being estimated doesn't have a strong biological relationship with human disease cases.

Research Questions

1. Would the prevalence of the West Nile virus be underestimated by surveillance programs that target only the numbers of positive dead birds due to many mosquitoes feeding more often on sick birds with WNV?
2. Would this be true if the surveillance program targets only the numbers of infected mosquitoes?

Modeling with SEIR



Differential Equations for Birds

$$\frac{dS_B}{dt} = (\beta_B - (\beta_B - m_B) \frac{N_B}{K_B}) N_B - \frac{S_B + I_B}{S_B + xI_B} abI_M \frac{S_B}{N_B} - m_B S_B$$

$$\frac{dE_B}{dt} = \frac{S_B + I_B}{S_B + xI_B} abI_M \frac{S_B}{N_B} - \gamma_B E_B - m_B E_B$$

$$\frac{dI_B}{dt} = \gamma_B E_B - \alpha_B I_B - m_B I_B$$

$$\frac{dR_B}{dt} = (1 - v_B) \alpha_B I_B - m_B I_B$$

$$\frac{dD_B}{dt} = v_B \alpha_B I_B$$

Differential Equations for Mosquitoes

$$\frac{dL_M}{dt} = \beta_M(S_M + E_M + I_M)\left(1 - \frac{S_M + E_M + I_M}{K_M}\right) - ML_M - \nu_L L_M$$

$$\frac{dS_M}{dt} = -x \frac{S_B + I_B}{S_B + xI_B} acS_M \frac{I_B}{N_B} + ML_M - \nu_A S_M$$

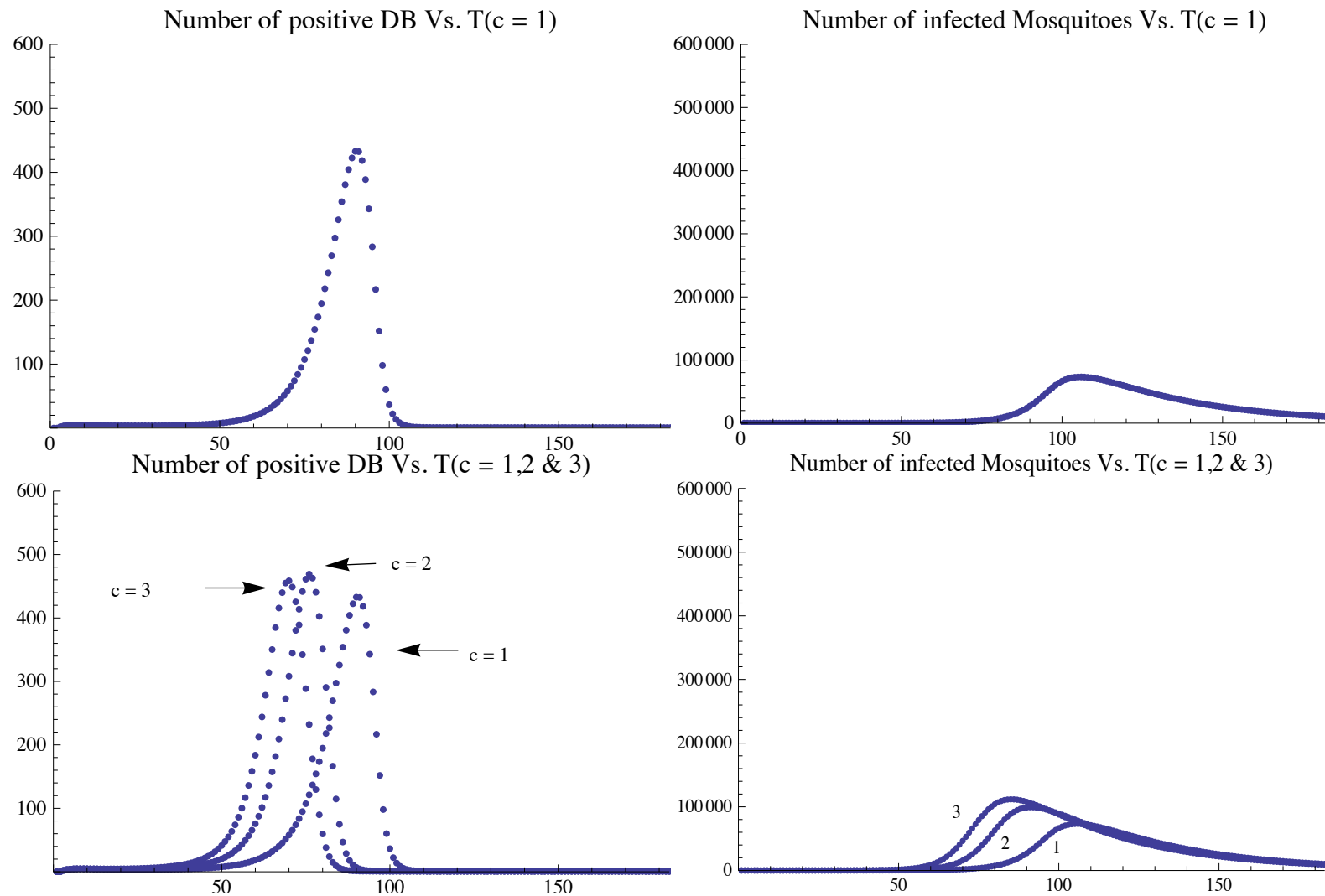
$$\frac{dE_M}{dt} = x \frac{S_B + I_B}{S_B + xI_B} acS_M \frac{I_B}{N_B} - kE_M - \nu_A E_M$$

$$\frac{dI_M}{dt} = kE_M - \nu_A I_M$$

Simulation's Initial Values

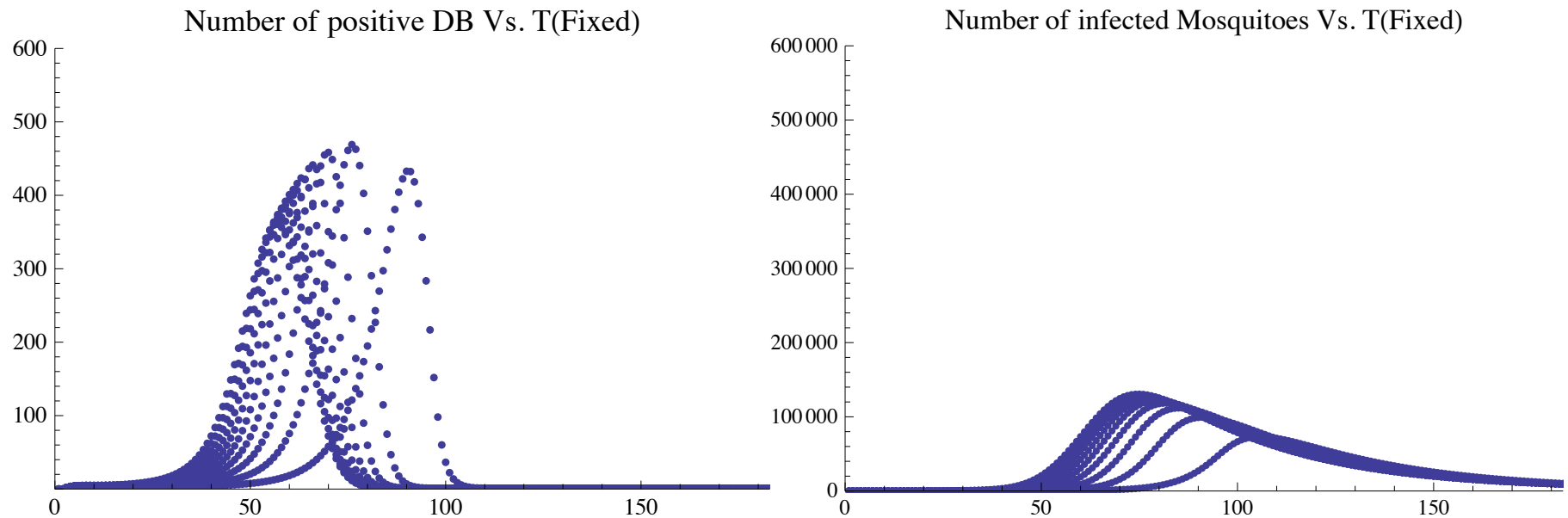
Parameter	values	Meaning
S_M	499900	Number of susceptible mosquitoes
S_B	11000	Number of susceptible birds
I_M	100	Number of infectious mosquitoes

Simulation Result I.I



As the attraction scale c of the sick bird increases, the number of positive dead birds and the number of infected mosquitoes tend to increase.

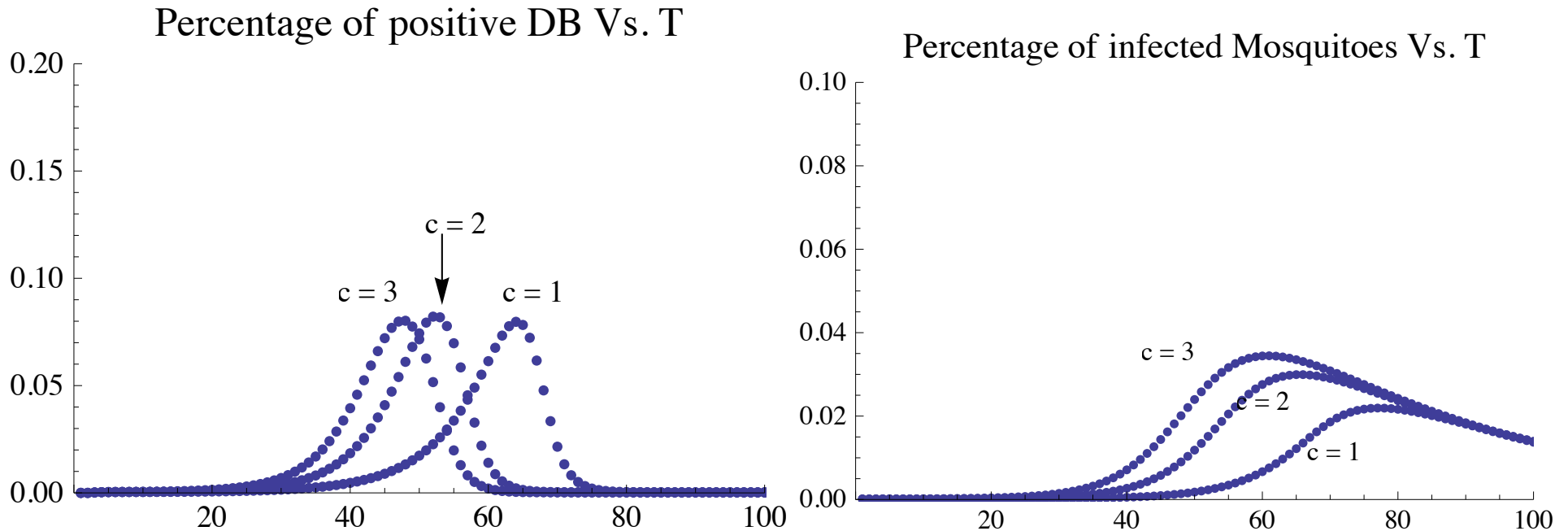
Simulation Result I.II



Note : c changes from 1 to 10 by 1

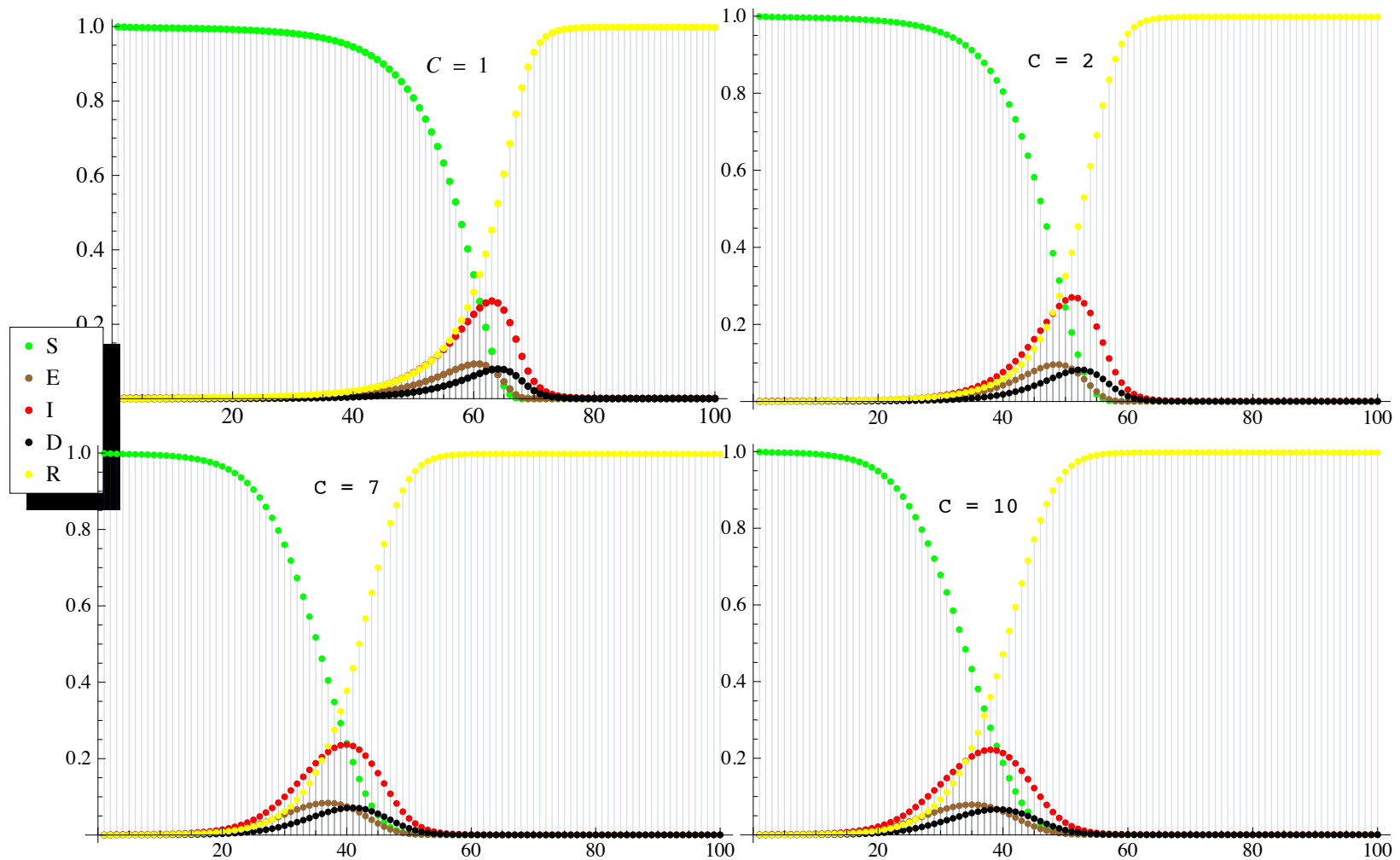
As the attraction scale c of the sick bird increases, the number of positive dead birds and the number of infected mosquitoes tend to increase.

Simulation Result II.I



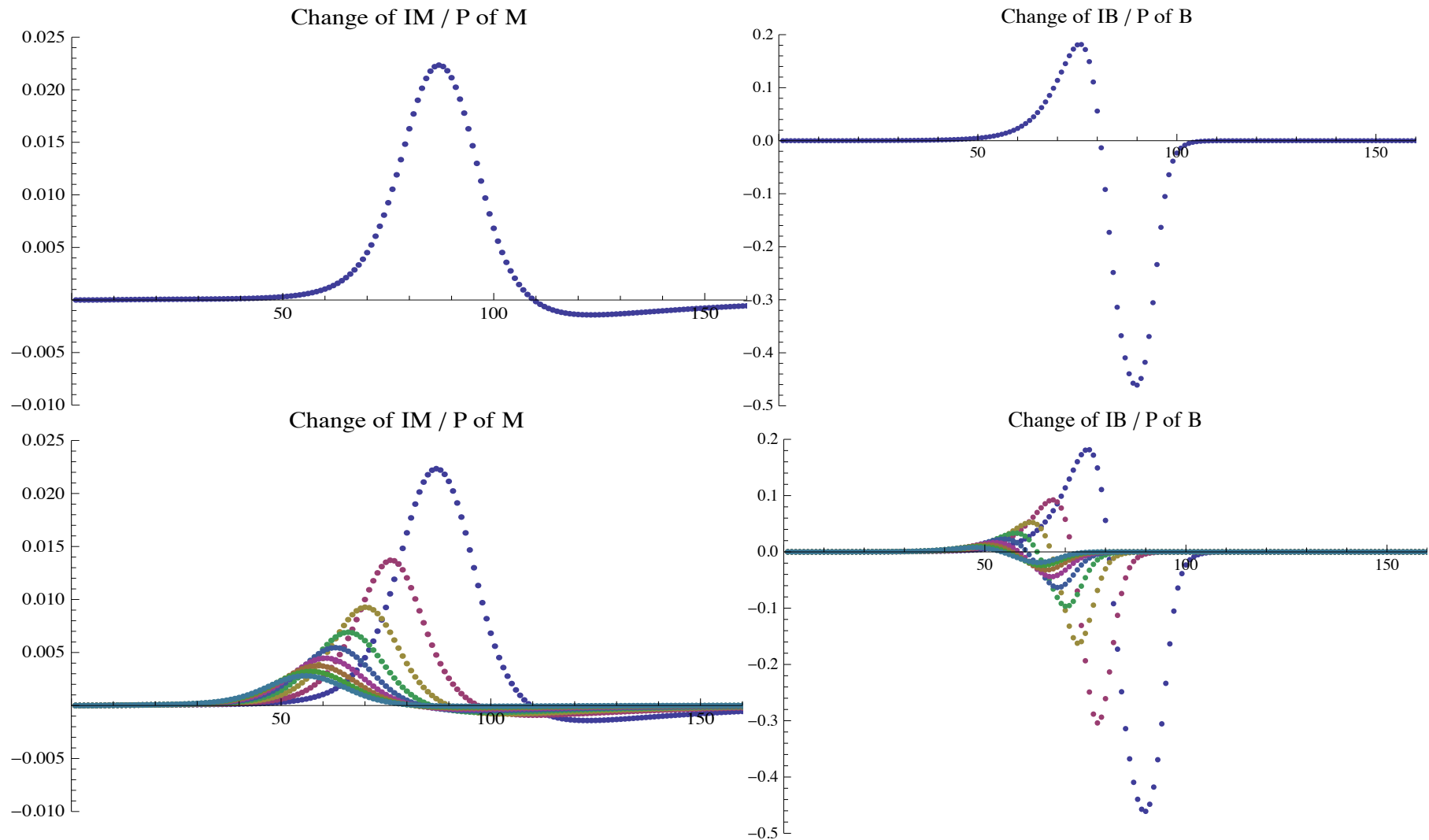
As the attraction scale c of the sick bird increases, the percentage of positive dead birds and the percentage of infected mosquitoes tend to increase for the same time. However, the WNV has a greater effect on the population of birds than that of mosquitoes.

Simulation Result II.II



Effect of Attraction Scale c to the Subgroups of Birds.

Simulation Result III



Effect of Attraction Scale to the Percentage Change of Birds and Mosquitoes in Their Populations

Conclusion

The prevalence of the WNV will be underestimated if the surveillance programs only record the number of positive dead birds with the assumption that the mosquitoes feed more often on the birds with WNV.

Reference

- Eldridge, B. F. 1987. Strategies for surveillance, prevention, and control of arbovirus diseases in western North America. American Journal of Tropical Medicine and Hygiene 37 (3): 77S-86S.
- West Nile Virus. A.D.A.M. Medical Encyclopedia. Web. June 6, 2011
- Epidemic/Epizootic West Nile Virus in the United States: Guidelines for Surveillance, Prevention, and Control.(2003). Centers for Disease Control and Prevention.

Thank You !!