

The mathematical model

When a susceptible¹ mosquito feeds on an infectious human, a number of gametocytes, G_0 , may be picked up in the blood meal, of which a fraction m are male and the remainder $(1-m)$ are female. Within minutes of ingesting these gametocytes, gametogenesis begins, which results in the formation of the respective male and female gametes (see [2] and [3]). We assume a constant per gametocyte gametogenesis rate for males of c , and for females of d . The equations that model the decline in gametocytes due to gametogenesis are thus

$$\frac{dG_M}{dt} = -cG_M \quad (1)$$

$$\frac{dG_F}{dt} = -dG_F \quad (2)$$

The male gametes, M , produced at an efficiency $\alpha\rho$ either fertilize female gametes or die, and female gametes, F , produced at an efficiency $\nu\beta$ are either fertilized by male gametes or die. We assume a constant per microgamete death rate a (per day), and a constant per macrogamete death rate b (per day). We also assume that the fertilization rate will be proportional to both the number of male gametes and the number of female gametes, and we call this constant of proportionality r (per number of parasites per day). Thus the equations that model the male and female gamete populations become

$$\frac{dM}{dt} = \alpha\rho cG_M - aM - rMF, \quad (3)$$

$$\frac{dF}{dt} = \beta\nu dG_F - bF - rMF. \quad (4)$$

Upon fertilization of female gametes by male gametes (which occurs, fairly quickly, within an hour of gamete formation, see [2]), zygotes, Z , are formed.

Bibliography

- 1: Charlwood, J.D., Pinto, J., Sousa, C.A., Ferreira, C., Gil, V., Do Rosario, V.E., Mating does not affect the biting behaviour of *Anopheles gambiae* from the islands of Sao Tome and Principe, West Africa., 2003
- 2: Baton, L.A., Ranford-Cartwright, L.C., Spreading the seeds of million-murdering death: metamorphoses of malaria in the mosquito, 2005
- 3: Sinden, R.E., The cell biology of sexual development in *Plasmodium*, 1983

¹ Here we use susceptible to mean a mosquito that has not been exposed to the malaria parasite. However, an exposed mosquito may also feed on an infectious human since a significant fraction of mosquitoes feed multiple times (see [1]).