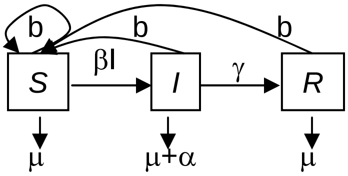

a. Directly transmitted microparasite model with density-dependent transmission

$$\frac{dS}{dt} = \overbrace{bN}^{\text{birth}} - \overbrace{\mu S}^{\text{death}} - \overbrace{\beta SI}^{\text{transmission}}$$

$$\frac{dI}{dt} = \overbrace{\beta SI}^{\text{transmission}} - \overbrace{(\gamma + \mu + \alpha)I}^{\text{recovery, death}}$$

$$\frac{dR}{dt} = \overbrace{\gamma I}^{\text{recovery}} - \overbrace{\mu I}^{\text{death}}$$

$$R_0 = \frac{\beta N}{\gamma + \mu + \alpha}, R_e = R_0 S / N$$

$$N_T = \frac{\gamma + \mu + \alpha}{\beta}, R_0 = N / N_T$$

<u>Equilibria</u>

$$S^* = \frac{\gamma + \mu + \alpha}{\beta}$$

$$I^* = \frac{[(\mu - b)(\mu + \alpha + \gamma)]}{\left[\beta\left(b\left(1 + \frac{\gamma}{\mu}\right) - (\mu + \alpha + \gamma)\right)\right]}$$

$$R^* = \frac{\gamma I^*}{\mu} \quad N^* = S^* + I^* + R^*$$

Symbols:
- S = susceptible hosts
- I = infected and infectious hosts
- R = recovered/immune hosts
- N = total host population = S+I+R
- b = per capita birth rate
- β = transmission rate (contact rate * infectiousness)
- μ = mortality rate without disease
- α = mortality rate due to disease
- γ = host recovery rate from infection

b. Multi-host vector-borne microparasite model with frequency-dependent transmission

$$\frac{dS_j}{dt} = \overbrace{b_j N_j}^{\text{birth}} - \overbrace{\mu_j S_j}^{\text{death}} - \overbrace{\frac{\beta f_j M_i S_j}{N_j}}^{\text{transmission}}$$

$$\frac{dI_j}{dt} = \overbrace{\frac{\beta f_j M_i S_j}{N_j}}^{\text{transmission}} - \overbrace{(\gamma_j + \mu_j + \alpha_j) I_j}^{\text{recovery, death}}$$

$$\frac{dR_j}{dt} = \overbrace{\gamma_j I_j}^{\text{recovery}} - \overbrace{\mu_j R_j}^{\text{death}}$$

$$\frac{dL}{dt} = \overbrace{F \sum_{j=1}^{n} \beta_j M}^{\text{larval birth}} - \overbrace{(\phi + \mu_L) L}^{\text{maturation, death}}$$

$$\frac{dM_u}{dt} = \overbrace{\phi L}^{\text{maturation}} - \overbrace{\sum_{j=1}^{n} \frac{\beta f_j c_j I_j M_u}{N_j}}^{\text{transmission/exposure}} - \overbrace{\mu_M M_u}^{\text{death}}$$

$$\frac{dM_e}{dt} = \overbrace{\sum_{j=1}^{n} \frac{\beta f_j c_j I_j M_u}{N_j}}^{\text{transmission/exposure}} - \overbrace{(q + \mu_M) M_e}^{\text{transition, death}}$$

$$\frac{dM_i}{dt} = \overbrace{q M_e}^{\text{transition}} - \overbrace{\mu_M M_i}^{\text{death}}$$

$$R_{e\,n\,hosts}^{2} = \sum_{j=1}^{n} \frac{\beta^2 c_i \frac{S_j}{N_j} \frac{f_j^2 M_u}{N_j} \frac{q}{q + \mu_m}}{\mu_m (\mu_j + \gamma_j + \alpha_j)}$$

Additional Symbols:
- M = adult mosquito density
- c = host infectiousness
- q = vector transition rate, exposed to infectious
- L = larval mosquitoes
- β=vector biting rate
- ϕ= developmental rate, larvae to adult
- f_j = fraction of vector bites from host j
- F = vector fecundity
- Subscripts: j = host species j, L = larvae
- M = mosquito, u-uninfected, e-exposed, i-infectious

c. Macroparasite model with free-living larval stage

$$\frac{dH}{dt} = \overbrace{(b - \mu) H}^{\text{birth, 'natural' death}} - \overbrace{(\alpha + \delta) P}^{\text{parasite effects on birth, death}}$$

$$\frac{dW}{dt} = \overbrace{\lambda P - \mu_W W}^{\text{worm birth, death}} - \overbrace{\beta WH}^{\text{transmission}}$$

$$\frac{dP}{dt} = \overbrace{\beta WH}^{\text{transmission}} - \left[\overbrace{\alpha\left(1 + \frac{P}{H}\frac{k+1}{k}\right)}^{\text{parasite death}^1} + (\overbrace{\mu}^{\text{death}^2} + \overbrace{\mu_P}^{\text{death}^3})\right] P$$

$$R_0 = \frac{\beta \lambda H}{(\alpha + \mu + \mu_P) + (\mu_W + \beta H)}$$

Additional Symbols:
- H = host
- W = larval worm parasites
- P = adult parasites
- δ = reduction in reproduction due to parasite
- λ = fecundity of parasite
- 1/k = parasite aggregation