These are electronic appendices to the paper by Holland *et al*. 2004 Evolutionary stability of mutualism: interspecific population regulation as an evolutionarily stable strategy. *Proc. R. Soc. Lond.* B **271**, 1807–1814. (DOI 10.1098/rspb.2004.2789.)

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## ELECTRONIC APPENDIX A.

List of symbols of model variables and parameters, and their definitions.

| **Symbol** | **Meaning** |
|---|---|
| $M$ | Pollinator population density |
| $\gamma_1$ | Rate of flower pollination by pollinators |
| $\gamma_2$ | Rate of flower oviposition by pollinators |
| $\delta$ | Pollinator mortality rate |
| $F_i$ | Flower production of individual *i* |
| $P_i$ | Fraction of flowers pollinated of individual *i* |
| $D_i$ | Fraction of flowers parasitized of individual *i* |
| $R_{fl,i}$ | Resources available for flower production by individual *i* |
| $R_{fr,i}$ | Resources available for fruit production by individual *i* |
| $R_{t,i}$ | Total resources available for reproduction by individual *i* |
| $\alpha$ | Conversion efficiency of resources into flowers |
| $\beta$ | Conversion efficiency of resources into mature fruit |
| $G_i$ | Potential fruit production by individual *i*, given available resources |
| $F_{s,i}$ | Fruit set or initiation of individual i, given pollination and resources |
| $W_{F,i}$ | Female fitness (seed or fruit production) of individual *i* |
| $W_{M,i}$ | Male fitness (pollen dispersal and donation) of individual *i* |
| $W_i$ | Fitness of plant individual *i* |

## ELECTRONIC APPENDIX B

An analytic approximation of (6) for the ratio-dependent case is possible by expanding the exponentials, keeping up to second order terms, as

$$e^{-\gamma_2 M/F} \cong 1-\gamma_2 M/F+(1/2)(\gamma_2 M/F)^2 \qquad \text{(A1)}$$

$$e^{-\gamma_1 M/F} \cong 1-\gamma_1 M/F+(1/2)(\gamma_1 M/F)^2 \qquad \text{(A2)}$$

From equation (A1), when $\beta R_t R_{fr} > PF$, the right hand side of equation (7) can approximated and solved to obtain the equilibrium value of *M*:

$$M = 2F(\gamma_2 - d)/{\gamma_2}^2 = 2\alpha R_{fl} R_t(\gamma_2 - d)/{\gamma_2}^2 \qquad \text{(A3)}$$

From equation (A2), when $\beta R_t R_{fr} < PF$, the right hand side of equation (8) is approximated and solved for equilibrium to obtain;

$$M = \beta R_t R_{fr}(\gamma_2/\gamma_1)/d = \beta R_t(1-R_{fl})(\gamma_2/\gamma_1)/d \qquad \text{(A4)}$$

(In this case only the first order terms of the expansion are used.) Now it can be seen that as $R_{fl}$ is increased from zero to larger values, as long as $\beta R_t R_{fr} > PF$, *M* increases linearly with $R_{fl}$. However, when the inequality is reversed, so that $\beta R_t R_{fr} < PF$, *M* decreases as a function of $R_{fl}$. Thus, *M* is a unimodal function of $R_{fl}$. This is a reasonable quantitative approximation of the 'exact' equations. The above approximations for *M* can be used in equations (4) and (5). When $\beta R_t R_{fr} > PF$ the female fitness function is $W_F = \alpha R_t R_{fl}(e^{-2(\gamma_2-d)/\gamma_2} - e^{-2\gamma_1(\gamma_2-d)/{\gamma_2}^2})$. When $\beta R_t R_{fr} < PF$, the female fitness function is

$W_F = \beta R_t(1-R_{fl})(e^{-\beta(1-R_{fl})[{\gamma^2}_2/(d\gamma_1\alpha R_{fl})]} - e^{-\beta(1-R_{fl})[\gamma_2/(d\alpha R_{fl})]})/(1-e^{-\beta(1-R_{fl})[\gamma_2/(d\alpha R_{fl})]})$.

## ELECTRONIC APPENDIX C

Values of flower production strategies, $R_{fl}$, for plant fitness for the ecological model and for evolutionarily stable strategies for a wide range of parameter values of $\alpha$, $\beta$, $\delta$, $\gamma_1$, and $\gamma_2$., for standard male fitness. Results are for ratio-dependent functional responses.

|  |  |  |  |  | **Flower Production Strategy ($R_{fl}$)** |  |
|---|---|---|---|---|---|---|
| $\alpha$ | $\beta$ | $\delta$ | $\gamma_1$ | $\gamma_2$ | **Ecological $R_{fl}$** | **ESS $R_{fl}$** |
| 1.0 | 1.0 | 0.5 | 6.0 | 3.0 | 0.83 | 0.73 |
| 2.0 | 1.0 | 0.5 | 6.0 | 3.0 | 0.72 | 0.66 |
| 3.0 | 1.0 | 0.5 | 6.0 | 3.0 | 0.64 | 0.62 |
| 4.0 | 1.0 | 0.5 | 6.0 | 3.0 | 0.60 | 0.59 |
| 8.0 | 1.0 | 0.5 | 6.0 | 3.0 | 0.46 | 0.55 |
| 1.0 | 2.0 | 0.5 | 6.0 | 3.0 | 0.90 | 0.79 |
| 1.0 | 4.0 | 0.5 | 6.0 | 3.0 | 0.94 | 0.84 |
| 2.0 | 1.0 | 1.0 | 6.0 | 3.0 | 0.59 | 0.60 |
| 2.0 | 1.0 | 0.5 | 5.0 | 3.0 | 0.72 | 0.66 |
| 2.0 | 1.0 | 0.5 | 4.0 | 3.0 | 0.72 | 0.66 |
| 2.0 | 1.0 | 0.5 | 3.0 | 2.0 | 0.64 | 0.62 |
| 2.0 | 1.0 | 0.5 | 3.0 | 1.0 | 0.54 | 0.57 |