Supplemental Information

The SEIR Model

Here we present the full Susceptible-Exposed-Infected-Removed or "SEIR" model used to derive eq. 3 in the text. For the fall armyworm and other baculovirus-driven systems, disease transmission occurs during the larval stage. The model describes disease transmission over the course of an epizootic and allows for the observed delay between infection and virus production via larval death. The equations take the form:

$$\frac{dS}{dt} = -\bar{\beta}SV \left[\frac{S(t)}{S(0)}\right]^{K^2},$$ (S1)

$$\frac{dE_1}{dt} = \bar{\beta}SV \left[\frac{S(t)}{S(0)}\right]^{K^2} - m\delta E_1,$$ (S2)

$$\frac{dE_i}{dt} = m\delta E_{i-1} - m\delta E_i, i = 2, \dots m,$$ (S3)

$$\frac{dV}{dt} = m\delta E_m - \mu V.$$ (S4)

S is the density of uninfected or "susceptible" hosts and V is the density of virus-killed cadavers, as in the main text. Heterogeneity in disease risk can be adequately described by the first two moments of the distribution of transmission rates (Elderd, Dushoff & Dwyer 2008). $\bar{\beta}$ and K are derived from these moments. The above equations assume that transmission rates follow a probability distribution with mean $\bar{\beta}$ and coefficient of variation K. Differences in risk are captured by the disease transmission rate scaling factor, $\left[\frac{S(t)}{S(0)}\right]^{K^2}$. The time delay between baculovirus infection and death is represented by the exposed class E_i, which is divided into m classes, such that the average speed of kill is $1/\delta$. The rate at which individuals move from one class to the next is $m\delta$ (Keeling & Rohani 2008). Once larvae reach the final exposed class m, they die and become infectious cadavers V. Cadavers

break down at rate μ. The above equations assume no reproduction in the susceptible class and describe disease transmission in a single generation. In the main text, eq. 2 is eq. S1.

Calculating the AIC$_c$

To calculate the small sample correction to the AIC or the AIC$_c$ we used:

$$\text{AIC}_c \;\; = \;\; -2L(\theta) + 2K \left(\frac{n}{n - K - 1} \right). \tag{S5}$$

Here $L(\theta)$ is the log likelihood of the model parameters θ given the data, n is the number of experimental units or plots and K is the number of parameters in the model (Burnham & Anderson 2002). To calculate the log likelihood, we assumed that the error in the model followed a binomial distribution, as is appropriate for infection data. After fitting the model to the data, the residuals were examined for outliers, which were removed. Because binomial data are often over dispersed, we calculated the variance inflation factor (McCullagh & Nelder 1989). The metric was always much less than four, which means that overdispersion is not a factor in the data and should be of no concern in the analysis (Burnham & Anderson 2002).

To calculate the weights associated with each AIC score, we first calculated the ΔAIC_c where:

$$\Delta\text{AIC}_i = \text{AIC}_i - \min(\text{AIC}), \tag{S6}$$

Note we have dropped the small sample correction term c for convenience. Here i is the model being considered and $\min(\text{AIC})$ is the minimum of all AIC model scores. The ΔAIC

scores were then used to calculate the associated AIC weights:

$$w_i \quad = \quad \frac{\exp(-0.5\Delta\mathrm{AIC}_i)}{\Sigma_{r=1}^{R}\exp(-0.5\Delta\mathrm{AIC}_r)} , \qquad\qquad (S7)$$

where w_i is the weight of evidence for model i given all R models.

Table S1: rmANOVA results for the effects of Open-Top Chambers (OTCs) on daytime and nighttime temperatures during the field transmission experiments showing the degrees of freedom (df), the F-statistics, and the associated P-value. Daytime is defined as between 10 am and 4 pm. Nighttime is defined as between 10 pm and 4 am. Degrees of freedom differ among experimental trials based on the length of the experiment and the number of iButtons used.

Factor	df	F	P
Day			
October 2010			
OTC Effect	1,4	15.19	0.0176
Time	1,16	44.34	< 0.0001
OTC*Time	1,16	0.07	0.7928
July 2011			
OTC Effect	1,4	17.84	0.0134
Time	1,4	13.76	0.0207
OTC*Time	1,4	0.15	0.7226
September 2011			
OTC Effect	1,4	8.03	0.0472
Time	1,4	1.85	0.2451
OTC*Time	1,4	0.06	0.8148
Night			
October 2010			
OTC Effect	1,4	3.63	0.1293
Time	1,16	32.07	< 0.0001
OTC*Time	1,16	0.00	0.9463
July 2011			
OTC Effect	1,4	3.25	0.1456
Time	1,4	0.00	0.9867
OTC*Time	1,4	1.11	0.3524
September 2011			
OTC Effect	1,4	21.50	0.0098
Time	1,4	1526.19	< 0.0001
OTC*Time	1,4	28.93	0.0058

Table S2: rmANOVA results for the effects of Open-Top Chambers (OTCs) on daytime and nighttime humidity during the field transmission experiments showing the degrees of freedom (df), the F-statistics, and the associated P-value. Daytime is defined as between 10 am and 4 pm. Nighttime is defined as between 10 pm and 4 am. Degrees of freedom differ among experimental trials based on the length of the experiment and the number of iButtons used.

Factor	df	F	P
Day			
October 2010			
OTC Effect	1,4	0.11	0.7517
Time	1,16	4.02	0.0623
OTC*Time	1,16	1.48	0.2408
July 2011			
OTC Effect	1,3	0.69	0.4665
Time	1,3	2.69	0.1992
OTC*Time	1,3	0.72	0.4587
September 2011			
OTC Effect	1,2	9.82	0.0885
Time	1,2	15.99	0.0572
OTC*Time	1,4	1.56	0.3374
Night			
October 2010			
OTC Effect	1,4	0.07	0.8083
Time	1,16	4.24	0.0563
OTC*Time	1,16	0.01	0.9441
July 2011			
OTC Effect	1,4	3.25	0.1456
Time	1,4	0.00	0.9867
OTC*Time	1,4	1.11	0.3524
September 2011			
OTC Effect	1,2	0.12	0.7579
Time	1,2	1.88	0.3043
OTC*Time	1,2	0.12	0.7579

Figure S1: Open-top chamber (OTC) used to raise temperatures in the field experiments. In the center of the OTC, a single soybean plant was placed. The plant was enclosed in a mesh bag to prevent larval escape.
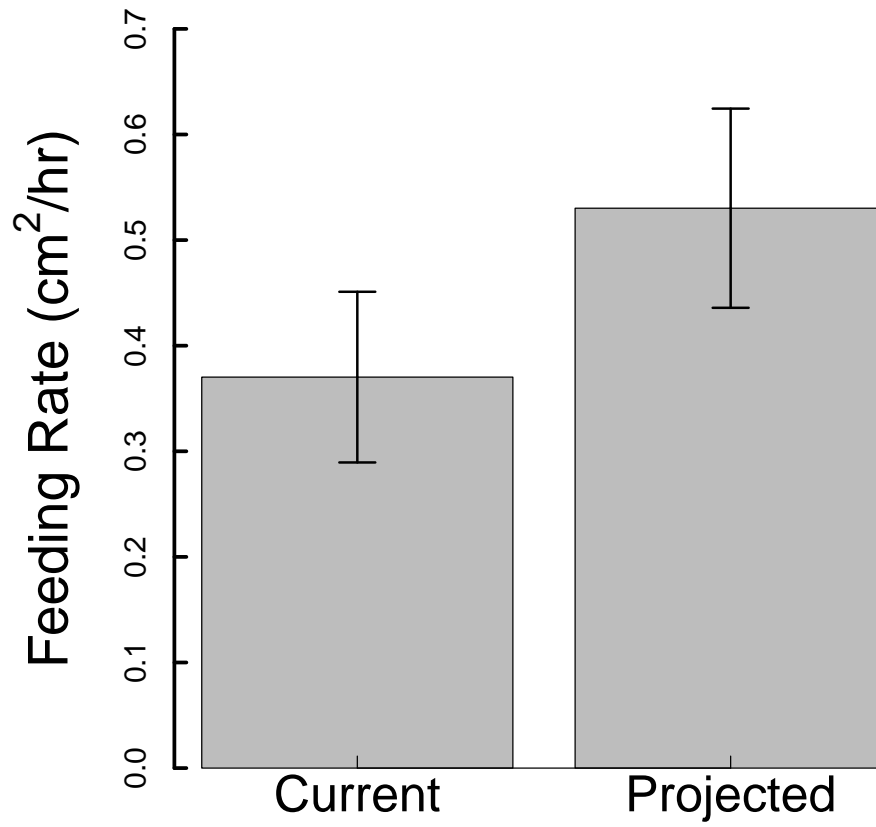
Figure S2: The effect of current and 2099 projected July average temperature on the mean feeding rate (± 95% confidence intervals) of fourth instar larvae.
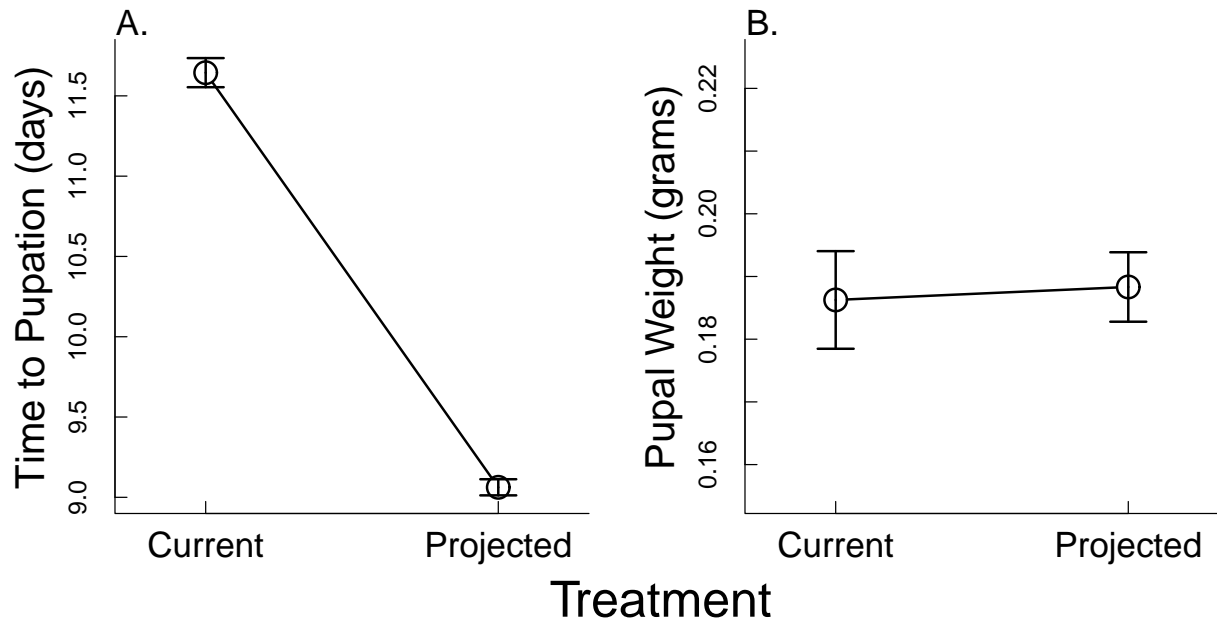
Figure S3: Mean ($\pm$ 95% confidence intervals) of A) time to pupation and B) weight at pupation for fall armyworm larvae raised under current and 2099 projected July average temperatures.

Supplemental Information References

Burnham, K. & Anderson, D. (2002) *Model selection and multimodal inference: A practical information-theoretic approach.* Springer, New York.

Elderd, B.D., Dushoff, J. & Dwyer, G. (2008) Host-pathogen dynamics, natural selection for disease resistance, and forest-defoliator outbreaks. *American Naturalist*, **172**, 829–842.

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