

APPENDIX S2: MORE STATISTICAL AND EMPIRICAL RESULTS

In this appendix, we present additional results from fitting of and competition among the various hypotheses constructed to explain transmission rate of a fungal parasite to *Daphnia* host as function of food quantity, spore density, and body size. We first provide results from the model competition using the Spore Gradient experiment. This experiment, unlike the Food Gradient version, was not able to distinguish among many competing hypotheses (Table S1). The Spore Gradient experiment could definitely eliminate hypothesis 1 (transmission rate is proportional to clearance rate only; Table 1) and hypothesis 8 (it is proportion to clearance rate times gut handling time multiplied by gut volume). These two hypotheses had high Akaike differences (Δ_i) and very low Akaike weights (w_i). Several other hypotheses (H3, H4.c, H6) were virtually indistinguishable, and the null model performed poorly.

We also consider whether ranking of model performance using data from the Food Gradient experiment would change with variation in maximal surface-area specific feeding rate, \hat{f} , and half-saturation constant, K . This examination is important because results presented in Table 1 are conditional on the parameter estimates for \hat{f} and K which we gleaned from the literature. However, due to relationships between \hat{f} and the infectivity parameter, β , we could not estimate both simultaneously. We therefore varied \hat{f} while holding K constant, and found that the relative ranking of the models did not change (Fig. S2). However, performance of the two surface-area based models (Hypotheses 3.a and 3.c) converged as the half-saturation constant dropped (while holding feeding rate constant; Fig. S2). We also show that this convergence of H3.a and H3.c occurs, not surprisingly, when β and K are estimated simultaneously but \hat{f} is held constant (Table S2). The best-fitting values of K remain within the range of estimates of a variety of species of *Daphnia* (summarized by Nisbet et al. 2004). Thus, although the details can vary, these different fits of the foraging-based models consistently supported transmission based models that incorporated clearance rate, based on type I and III functional response, and some measure of gut size, especially surface area.

Additional Literature Cited

Nisbet, R.M., McCauley, E., Gurney, W.S.C., Murdoch, W.W., & Wood, S.N. (2004).

Formulating and testing a partially specified dynamic energy budget model. *Ecology*, 85,
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Table S1. Results of competition among models for transmission rate (TR) for the Spore Gradient experiment. Fits of each model led to estimates of the infectivity parameter ($\beta \times 10^{-3}$), negative log likelihood (NLL), the Akaike information criterion (AIC), AIC differences for each model i (Δ_i), and Akaike weights (w_i). Models are sorted by AIC differences, from best to worst.

5 See Table 2 for changes in the units of the infectivity parameter for each model.

H	Formula: $TR =$	$\beta \times 10^{-3}$	NLL	AIC	Δ_i	w_i
4.c	$\varepsilon\beta CR_3 \times V_G$	450.3	210.4	422.7	0.00	0.22
3.a	$\varepsilon\beta CR_1 \times SA_G$	28.2	210.4	422.8	0.04	0.21
3.c	$\varepsilon\beta CR_3 \times SA_G$	33.2	210.5	423.1	0.34	0.18
6	$\varepsilon\beta CR_j \times T_{G,j} \times L_G$	2.03	210.7	423.4	0.66	0.16
3.b	$\varepsilon\beta CR_2 \times SA_G$	16.3	210.8	423.5	0.80	0.15
4.a	$\varepsilon\beta CR_3 \times L_G$	335.5	211.8	425.7	2.9	0.05
7	$\varepsilon\beta CR_j \times T_{G,j} \times SA_G$	16.7	213.6	429.3	6.5	0.0084
4.b	$\varepsilon\beta CR_2 \times V_G$	198.8	213.7	429.4	6.7	0.0077
2.b	$\varepsilon\beta CR_2 \times L_G$	0.23	214.1	430.1	7.4	0.0054
5	$\varepsilon\beta CR_j \times T_{G,j}$	2.87	214.1	430.1	7.4	0.0054
2.c	$\varepsilon\beta CR_3 \times L_G$	0.47	214.5	431.0	8.2	0.0035
2.a	$\varepsilon\beta CR_1 \times L_G$	0.40	214.9	431.9	9.2	0.0022
8	$\varepsilon\beta CR_j \times T_{G,j} \times V_G$	1694	222.7	447.4	24.6	9.8×10^{-7}
1.b	$\varepsilon\beta CR_2$	0.33	223.9	449.8	27.0	3.0×10^{-7}
1.c	$\varepsilon\beta CR_3$	0.66	224.9	451.9	29.2	1.0×10^{-7}
1.a	$\varepsilon\beta CR_1$	0.56	226.0	454.0	31.3	3.5×10^{-8}
0	β	2.92×10^{-3}	262.9	527.9	105.1	3.2×10^{-24}

Table S2. Results of competition among models for transmission rate (TR) for the Food Density experiment, where now two parameters were estimated: the infectivity parameter ($\beta \times 10^{-3}$) and the half-saturation constant (K). (Thus, these results remain conditional on the literature-based estimate of feeding rate; Table 1). Other results include: negative log likelihood (NLL), the Akaike information criterion (AIC), AIC differences for each model i (Δ_i), and Akaike weights (w_i). Models are sorted by AIC differences, from best to worst. See Table 2 for changes in the units of the infectivity parameter for each model.

H	Formula: $TR =$	$\beta \times 10^{-3}$	K	NLL	AIC	Δ_i	w_i
3.a	$\varepsilon\beta CR_1 \times SA_G$	45.0	0.35	163.1	330.2	0.00	0.52
3.c	$\varepsilon\beta CR_3 \times SA_G$	45.4	0.30	163.2	330.4	0.19	0.47
2.a	$\varepsilon\beta CR_1 \times L_G$	0.68	0.37	167.1	338.1	7.9	0.010
2.c	$\varepsilon\beta CR_3 \times L_G$	0.71	0.34	167.9	339.9	9.6	0.0042
4.a	$\varepsilon\beta CR_3 \times L_G$	267.4	0.12	169.3	342.7	12.5	1.0×10^{-03}
1.a	$\varepsilon\beta CR_1$	1.17	0.51	184.6	373.3	43.0	2.3×10^{-10}
1.c	$\varepsilon\beta CR_3$	1.06	0.37	186.3	376.5	46.3	4.6×10^{-11}
3.b	$\varepsilon\beta CR_2 \times SA_G$	15.1	0.60	211.5	427.0	96.8	5.0×10^{-22}
6	$\varepsilon\beta CR_j \times T_{G,j} \times L_G$	1.87	0.62	211.5	427.0	96.8	5.0×10^{-22}
5	$\varepsilon\beta CR_j \times T_{G,j}$	2.73	0.63	216.3	436.6	106.4	4.0×10^{-24}
2.b	$\varepsilon\beta CR_2 \times L_G$	0.22	0.60	216.3	436.6	106.4	4.0×10^{-24}
4.b	$\varepsilon\beta CR_2 \times V_G$	176.9	0.60	218.1	440.2	110.0	6.9×10^{-25}
7	$\varepsilon\beta CR_j \times T_{G,j} \times SA_G$	14.8	0.64	218.1	440.2	110.0	6.9×10^{-25}
4.c	$\varepsilon\beta CR_3 \times V_G$	594.8	0.38	221.7	447.5	117.3	1.8×10^{-26}
1.b	$\varepsilon\beta CR_2$	0.31	0.60	234.2	472.4	142.2	7.0×10^{-32}
8	$\varepsilon\beta CR_j \times T_{G,j} \times V_G$	1436	0.57	234.5	473.0	142.8	5.1×10^{-32}

Figure S2. Performance of the top models for transmission rate in response to variation in maximum surface area-specific feeding rate, \hat{f} , and half-saturation constant, K . Models are judged by Akaike Information Criterion (AIC); lower AIC indicates better support for a model. Hypotheses 3.a and 2.a involve clearance rate based on type I functional response and either surface area or length of the gut (respectively), while hypotheses 3.c and 2.c use the type III functional response for clearance rate and surface area or length of gut (respectively).

Figure S3. Behavior of the two-best fitting models over gradients of food and spore density for three different sizes of animals. These predictions emphasize importance of body size for infection prevalence: large animals become much more readily infected than smaller animals overall. Additionally, variation in food density (high levels for type I functional responses, low and high levels for type III functional responses) matters most for transmission rate when spores are dense enough to cause intermediate levels of infection. At low and high levels of infection, food density matters little.

Figure S2.

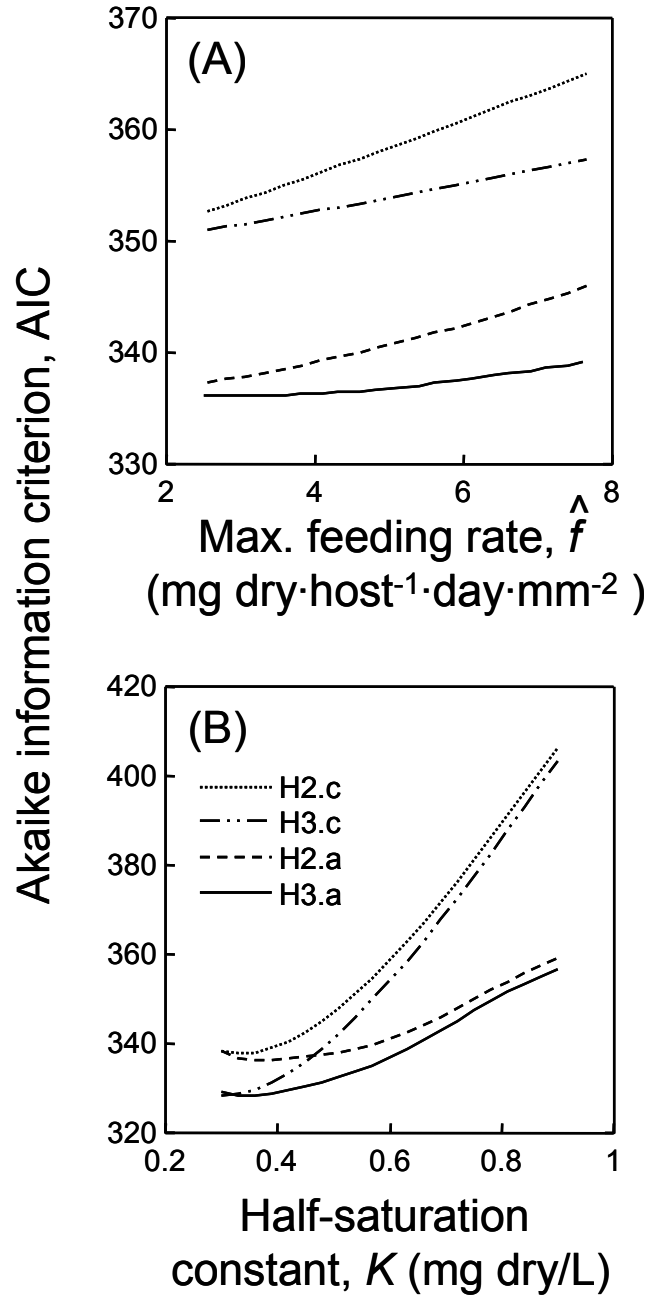


Figure S3.

