Supplementary materials

Text S1.

Daphnia culturing conditions

Prior to the *Pasteuria* infections, we maintained the *Daphnia* for three generations under standardized conditions. *Daphnia* were kept in an incubator at 20 °C with a 16:8 h light:dark cycle. We kept the *Daphnia* in beakers filled with 100 mL of filtered lake water with 6 adults/ beaker and fed each beaker 2 x 10^6 cells of *Ankistrodesmus falcatus* four times per week. We changed the water twice weekly, removing any new offspring. We started each new generation with offspring from the 3rd to 5th brood. For the infection assays, we collected <24-h old *Daphnia* neonates from the 3rd-4th brood from *Daphnia* mothers from the third generation of standard culturing conditions. We kept 10 neonates / 100 mL filtered lake water for two days (fed 2 x 10^6 million cells of *Ankistrodesmus* daily) immediately prior to exposure to *Pasteuria* spores.

Text S2.

Infection conditions

In our experiment, the 48-hour infection period and 24-day experiment were conducted in an incubator kept at 20 °C with a 16:8 h light:dark cycle. We housed the *Daphnia* in a darkened container during the 48-h infection period and kept the experimental animals in beakers of lake water housed in clear plastic containers for the remainder of the study.

We conducted pilot studies to determine 1) whether carrying out the 48-hour infections in darkened vs. clear plastic containers impacted infectivity or spore yields or 2) whether keeping *Daphnia* in darkened containers after the 48-hour infection period had any impact on *Pasteuria* infectivity.

For these pilots, we used *Pasteuria* spores from the control treatment from Crooked Lake, Pinckney (the darkest lake in the study that yielded infections) and Crooked Lake, Waterloo (the clearest lake that yielded infections). Our pilot included three experimental set up conditions: 1) *Daphnia* kept in darkened containers throughout the entire experiment (fully dark containers for the 48-h incubation period and containers covered with shade cloth for the remaining 24 days); 2) *Daphnia* kept in clear plastic containers for both the 48-hr incubation and 24 day experiment; and 3) *Daphnia* kept in darkened containers for the 48-hr incubation and in beakers housed in clear containers for the 24 day experiment. Treatment 3 is the set up we chose for the full experiment.

We used mixed effects modeling to test the effects of these treatments. The first model included infectivity as a binomial response variable, and the second model included spore yield as a zero truncated negative binomial response. Each model included experimental treatment (treatments 1, 2 or 3 for infectivity, treatments 2 or 3 for spore yield) as a fixed effect and *Pasteuria* strain as a random effect. Analyses were conducted in R v 3.5.2 (R Core Team 2016) using the lme4 (Bates et al. 2015) and glmmTMB (Brooks et al. 2017) packages for models 1 and 2 respectively.

We observed no effect of experimental conditions 1, 2 or 3 on infectivity (χ^2 =0.61, p=0.74, N=77). We also observed no difference between experimental conditions 2 and 3 on spore yields (χ^2 =0.01, p=0.92, N=30).

We conclude that keeping the *Daphnia* in beakers housed in clear plastic containers during the 24-day infection assays did not impact infectivity or spore yields. In addition, it is likely that we did not need to conduct the 48-hr incubations in a darkened container, but that this did not impact the main experiment.

References:

Bates, D., M. Maechler, B. M. Bolker, and S. Walker. 2015. Fitting linear mixed-effects models using {lme4}. J. Stat. Softw. 67:1–48.

Brooks, M. E. J. K. K., K. van Benthem, A. Magnusson, C. W. Berg, A. Nielsen, H. J. Skaug, M. Maechler, and B. M. Bolker. 2017. glmmTMB balances speed and flexibility among packages for zero-inflated generalized linear mixed modeling. R J. 9:378–400.

R Core Team. 2016. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.

Table S1. Chemical and physical characteristics of study lakes where *Pasteuria* spores were collected. Ultraviolet radiation (UVR) penetration absorption coefficient (a_{d320}) and dissolved organic carbon (DOC) are average values of measurements collected in summer-fall of 2014. DOC concentrations and UVR absorption coefficients were calculated following the methods of Rose et al. (2009). Each replicate *Pasteuria* strain was split in half, with half being exposed to ambient sunlight and half protected from sunlight during the field incubation; thus, there were two vials (one clear, and one darkened) for each strain.

Lake	**Location**	**Lat/Long**	**a_{d320}**	**DOC (mg/L)**	**Max. depth (m)**
North Lake	Dexter Township, MI	42.393, -84.0086	3.89	5.83	17
Crooked Lake, Waterloo	Sylvan Township, MI	42.325, -84.112	4.66	6.35	6
Cedar Lake	Sylvan Township, MI	42.315, -84.079	7.65	8.86	7.5
Midland Lake	Midland, Indiana	39.125, -87.178	8.14	6.86	7.5
Little Appleton Lake	Hamburg Township, MI	42.507, -83.839	11.81	4.69	6
Crooked Lake, Pinckney	Dexter Township, MI	42.419, -83.982	14.88	8.13	12
Walsh Lake	Sylvan Township, MI	42.338, -84.080	25.63	11.52	6

Reference:

Rose, K. C., C. E. Williamson, J. E. Saros, R. Sommaruga, and J. M. Fischer. 2009. Differences in UV transparency and thermal structure between alpine and subalpine lakes: implications for organisms. Photochem. Photobiol. Sci. 8:1244–1256.

Table S2. Details on the dates when *Pasteuria* infected *Daphnia* hosts were collected to yield the *Pasteuria* strains used in this study. Each strain combined the spores from 20 individual *Daphnia* hosts. On a few occasions, fewer than 20 individuals were found on a given sampling date and individuals from multiple dates were combined into one strain, as described below. Additional information on the lake locations and physical characteristics is found in Table S1.

Lake	Strain	Dates collected and notes
North	1	9/15/17
North	2	9/15/17
Crooked-W	1	9/5/17 (1 *Daphnia*) + 9/19/17 (19 *Daphnia*)
Cedar	1	8/23/17 (3 *Daphnia*); 9/5/19 (8 *Daphnia*); 9/19 (9 *Daphnia*)
Cedar	2	9/19/17
Midland	1	9/7/17
Little Appleton	1	9/18/17
Little Appleton	2	9/18/17
Crooked-P	1	8/16/17
Crooked-P	2	8/16/17
Crooked-P	3	8/16/17
Crooked-P	4	8/16/17
Crooked-P	5	8/16/17
Walsh	1	9/6/17

Table S3. Nested set of GLMM models used to test the effects of lake UVR availability (a_{d320}), experimental treatment (sunlight-exposure vs. control), and their interaction in explaining *Pasteuria* transmission potential. Parasite strain, as a random intercept, was included in each model. χ^2 and p values show results of log-likelihood comparisons of a given model with the model including one less fixed effect.

Response variable	**Fixed effects**	**AIC**	**logLik**	**χ^2**	**P value**
Transmission potential	a_{d320} x treatment	129.95	-58.97	5.30	0.021
Transmission potential	a_{d320} + treatment	133.25	-61.63	17.56	<0.001
Transmission potential	a_{d320}	148.81	-70.40	0.05	0.824
Transmission potential	null	146.86	-70.43		

Table S4. Nested set of models used to test the effects of lake UVR availability (ad_{320}), sunlight-exposure treatment, and their interaction in explaining *Pasteuria* infectivity (step 1 of hurdle model) and spore yield (step 2 of hurdle model). Infection status is a binomial variable and spore yield has a zero-truncated negative binomial distribution. Parasite strain, as a random intercept, was included in each model. χ^2 and p values show results of log-likelihood comparisons of a given model with the model including one less fixed effect.

Response variable	Fixed effects	AIC	logLik	χ^2	P value
Step 1 of hurdle model					
Infection status	a_{d320} x treatment	257.01	-124.51	1.24	0.266
Infection status	a_{d320} + treatment	256.25	-125.12	74.02	<0.001
Infection status	a_{d320}	328.27	-162.13	11.41	<0.001
Infection status	null	337.68	-167.84		
Step 2 of hurdle model					
Spore yield	a_{d320} x treatment	1899.0	-943.50	0.32	0.575
Spore yield	a_{d320} + treatment	1897.3	-943.66	0.69	0.405
Spore yield	a_{d320}	1896.0	-944.00	8.10	0.004
Spore yield	null	1902.1	-948.05		

Table S5. Nested set of GLMM models used to test the effects of transmission potential, experimental treatment (sunlight-exposure vs. control), and their interaction in explaining mean host offspring production (fecundity). Parasite strain, as a random intercept, was included in each model. χ^2 and p values show results of log-likelihood comparisons of a given model with the model including one less fixed effect.

Response variable	**Fixed effects**	**AIC**	**logLik**	**χ^2**	**P value**
Mean fecundity	Transmission potential x treatment	119.79	-52.90	10.41	0.001
Mean fecundity	Transmission potential + treatment	128.21	-58.10	13.70	<0.001
Mean fecundity	Transmission potential	139.91	-64.96	16.28	<0.001
Mean fecundity	null	154.19	-73.10		

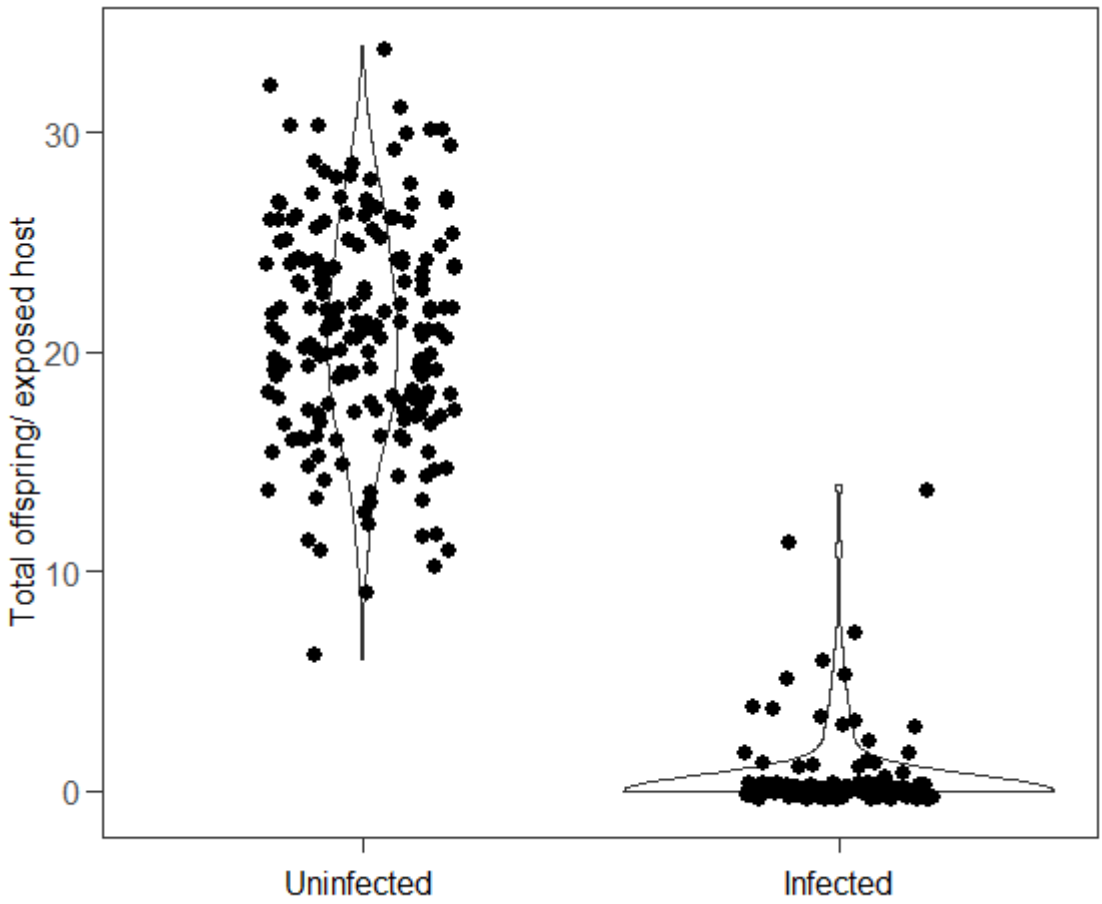

Figure S1. As expected, uninfected hosts produced many more offspring during the experiment than infected hosts did.