Supporting Information

Table S1. Location and environmental variation of altitudinal gradients where *D. birchii* was collected between 2010 – 12, including altitudinal range, total length (the straight-line distance between the top and bottom of each gradient in km), number of sites sampled, ranges of environmental variables (Mean daily temperature (MDT); Mean daily minimum temperature (MDT_{min}); Mean daily maximum temperature (MDT_{max}); Mean daily temperature difference (MDT_{diff}); Mean daily humidity (MDH)), *D. birchii* density, density of other species from the *serrata* species complex (non-*birchii* density), and productivity in cages (only assessed in 2012). For each environmental variable, density and cage productivity, the range shown is the mean at the lowest altitude site to the mean at the highest altitude site. Density of *D. birchii* and other *serrata*-complex species were not estimated in 2012. The difference in mean temperature between the most northerly gradient (Mt Lewis) and the most southerly gradient (Paluma) was less than the temperature difference seen within most of the altitudinal gradients

Gradient	Year	Latitude (° S)	Longitude (° E)	Alt. range (m)	Total length (km)	No. sites	MDT range (° C)	MDT_{min} range (° C)	MDT_{max} range (° C)	MDT_{diff} range (° C)	MDH range (%)	*D. birchii* density	Non-*birchii* density	Cage Productivity (mean no. offspring)
Mt Lewis	2010	16˚30.1'	145°23.7’	23–1233	16.3	30	26.1 – 18.6	23.4 – 17.3	29.9 – 20.2	6.5 – 2.9	91.1 – 94.2	0.03 – 0.00	0.62 – 0.00	-
	2011	16˚30.1'	145°23.7’	23–1233	16.3	26	24.1 – 17.0	21.8 – 15.7	27.4 – 18.5	5.6 – 2.8	91.2 – 100	0.01 – 0.00	2.96 – 0.00	-
Mt Edith	2011	17˚7.9'	145°37.2’	697–1105	4.3	10	19.4 – 17.5	17.4 – 16.3	21.6 – 18.9	4.2 – 2.6	98.6 – 95.3	0.77 – 0.09	0	-
	2012	17˚7.9'	145°37.2’	697–1105	4.3	4	15.2 – 13.6	11.7 – 10.9	19.3 – 16.4	7.6 – 5.5	99.5–95.4	-	-	32.76 – 1.95
Kirrama	2010	18˚12.3'	145°53.4’	59–791	10.0	18	23.1 – 19.6	21.9 – 18.3	25.3 – 21.5	3.4 – 3.2	97.9 – 97.4	0.09 – 0.40	0.91 – 0.00	-
Paluma	2011	18˚59.0'	146°14.0’	72–916	3.7	10	23.2 – 17.7	20.9 – 16.4	27.0 – 18.9	6.1 – 2.5	88.4 – 97.4	0.34 – 0.79	7.08 – 0.00	-
	2012	18˚59.0'	146°14.0’	72–916	3.7	4	19.7 – 14.7	16.3 – 11.4	23.5 – 20.9	7.2 – 9.5	74.3 – 78.3	-	-	36.54 – 1.82

Table S2: Linear regressions of each environmental variable measured during 2010–2012 on (a) altitude for each gradient, and (b) altitude, latitude and their interaction across the entire sampled range. Shown is the slope, with the Standard Error (SE) in brackets, of the regression line between each environmental variable and altitude/latitude, and the R^2 value indicating the proportion of variation explained by the model. *N* is the number of sites sampled. Symbols indicate the significance of each factor in the model: *** $P <$ 0.001, ** $0.001 \leq P < 0.01$, * $0.01 \leq P < 0.05$, † $0.05 \leq P < 0.1$, ^{NS} $P \geq 0.1$. Significant associations are highlighted in *italics*.

(a)

Gradient	**Environmental variable**	**Altitude**	R^2
Mt Lewis	*NONBIRCH*	*-0.0022 (0.0005)****	0.432
(*N* = 56)	MDT_{min}	*-0.0050 (0.0002)****	0.988
	MDT	*-0.0061 (0.0002)****	0.987
	MDT_{max}	*-0.0080 (0.0006)****	0.949
	MDT_{diff}	*-0.0030 (0.0003)****	0.811
	MDH	*0.0064 (0.0015)***	0.634
Mt Edith	NONBIRCH	-	-
(*N* = 10)	MDT_{min}	*-0.0029 (0.0009)**	0.713
	MDT	*-0.0050 (0.0010)***	0.860
	MDT_{max}	*-0.0070 (0.0021)**	0.734
	MDT_{diff}	*-0.0035 (0.0011)**	0.551
	MDH	-0.0080 (0.0043)^{NS}	0.465
Kirrama	*NONBIRCH*	*-0.0015 (0.0004)***	0.403
(*N* = 18)	MDT_{min}	*-0.0048 (0.0002)****	0.981
	MDT	*-0.0048 (0.0002)****	0.990
	MDT_{max}	*-0.0052 (0.0003)****	0.972
	$\mathrm{MDT_{diff}}$	-0.0004 (0.0003)^{NS}	0.119
	MDH	-0.0007 (0.0013)^{NS}	0.034
Paluma	*NONBIRCH*	*-0.0046 (0.0019)**	0.420
(*N* = 10)	MDT_{min}	*-0.0055 (0.0004)****	0.986
	MDT	*-0.0068 (0.0005)****	0.983
	MDT_{max}	*-0.0101 (0.0010)****	0.973
	MDT_{diff}	*-0.0046 (0.0003)****	0.958
	MDH	*0.0106 (0.0019)**	0.910

(b)

Gradient	**Environmental variable**	**Altitude**	**Latitude**	**Altitude x Latitude**	R^2
Overall (*N* = 94)	NONBIRCH	*0.0005 (0.0066)****	-0.0045 (0.2379)^{NS}	-0.0002 (0.0004)^{NS}	0.301
	$\mathrm{MDT_{min}}$	*-0.0011 (0.0050)****	*-0.4330 (0.1806)****	-0.0002 (0.0003)^{NS}	0.674
	MDT	*-0.0083 (0.0051)****	*-0.7746 (0.1837)****	0.0001 (0.0003)^{NS}	0.902
	$\mathrm{MDT_{max}}$	*-0.0168 (0.0077)****	*-1.197 (0.2800)****	0.0005 (0.0005)^{NS}	0.871
	$\mathrm{MDT_{diff}}$	*-0.0131 (0.0051)****	*-0.5372 (0.1878)**	*0.0006 (0.0003)**	0.584
	MDH	*0.0288 (0.0204)****	*1.7147 (0.7369)**	-0.0014 (0.0012)^{NS}	0.353

Table S3: Correlations between environmental variables included as predictors of *D. birchii* field abundance (below diagonal) and *p*-values indicating significance of correlations (above diagonal). All correlations were highly significant, even at a very conservative Bonferroni-corrected significance threshold of *P* = 0.003.

	NONBIRCH	**MDT_{min}**	**MDT**	**MDT_{max}**	**MDT_{diff}**	**MDH**
NONBIRCH	1	8.98×10^{-6}	2.06×10^{-7}	3.67×10^{-9}	2.50×10^{-11}	1.21×10^{-7}
MDT_{min}	0.440	1	$<2.20 \times 10^{-16}$	$<2.20 \times 10^{-16}$	4.01×10^{-12}	9.85×10^{-11}
MDT	0.505	0.982	1	$<2.20 \times 10^{-16}$	$<2.20 \times 10^{-16}$	1.86×10^{-14}
MDT_{max}	0.562	0.943	0.986	1	$<2.20 \times 10^{-16}$	$<2.20 \times 10^{-16}$
MDT_{diff}	0.621	0.639	0.766	0.860	1	$<2.20 \times 10^{-16}$
MDH	-0.513	-0.606	-0.688	-0.750	-0.798	1

Table S4. Loadings of each environmental variable measured along the four gradients on the first two Principal Components (PCs) from a Principal Component Analysis. The first two PCs together accounted for 89 % of the variation in these variables.

Variable	**PC1**	**PC2**
Abundance of non-*birchii* (NONBIRCH)	0.311	0.734
Mean Daily Temperature		
Minimum (MDT_{min})	0.417	-0.452
Mean (MDT)	0.444	-0.326
Maximum (MDT_{max})	0.458	-0.190
Range (MDT_{diff})	0.416	0.255
Mean Daily Humidity (MDH)	-0.386	-0.222
% Variation	**76.8**	**12.2**

Table S5. Variation in productivity among isofemale lines (nested in source population) from Mt Edith and Paluma when reared in the laboratory. Productivity variation was analysed using Generalised Linear Mixed Models (GLMMs), run in the *R* package *glmmADMB*, specifying zero-inflation, and a negative binomial distribution with a log link function. Source population (indicating which of the four populations within a gradient the line came from) was included as a fixed factor and maternal isofemale line ('Line'), nested within source population, was included as a random factor. Significant effects are denoted in *italics*. The significance of fixed effects was evaluated using a χ^2 test, and of random effects using a likelihood-ratio test comparing models with and without the term included. Separate analyses were conducted for the two gradients. Productivity was measured as the mean number of offspring per female produced from controlled crosses in the laboratory. Sites at both gradients differed significantly in their productivity in the lab (but not in the field; see Table 2). Estimates of among-line variance in productivity at both gradients were much higher in the laboratory than in the field (*cf* Table 2), and this variance was significant at Mt Edith.

	Fixed effects				***Random effects***		
Gradient	**Predictor**	**d.f.**	χ^2	***P***	**Variance component**	**Variance**	***P***
Mt Edith	*Source population*	*3*	*20.91*	*0.00011*	*Line*	*1.942*	*0.00071*
	Residual	153					
Paluma	*Source population*	*3*	*51*	4.89×10^{-11}	Line	0.046	0.366
	Residual	153					

Table S6. Results of linear models to test how well mean fitness in cages (cage productivity) predicts local abundance in the field. Separate analyses were performed for Mt Edith and Paluma, the two gradients where caged transplants were performed. All fitness and abundance data were standardized to mean = 0; standard deviation = 1 prior to analysis. Shown are the slopes of the regressions of cage productivity on local abundance at each gradient, with the standard error of this estimate in brackets, the *t*-value for the analysis, and the significance of each test.

Gradient	**Parameter**	**Estimate (SE)**	***t***	***P***	**Model statistics**
Mt Edith	Intercept	1.441 (0.482)	2.991	0.020	*Adj.* R^2 = 0.353
	Cage productivity	1.313 (0.567)	2.316	0.054	$F_{1,7}$ = 5.365
					P = 0.054
Paluma	Intercept	0.012 (0.085)	0.138	0.893	*Adj.* R^2 = 0.508
	Cage productivity	*-0.253 (0.079)*	*-3.210*	*0.012*	$F_{1,8}$ = 10.3
					P = 0.012

LOW 1

		Maternal Isofemale Line				
		L1-1	L1-2	L1-3	L1-4	L1-5
Paternal Isofemale Line	L1-1		X	X	X	X
	L1-2	X		X	X	X
	L1-3	X	X		X	X
	L1-4	X	X	X		X
	L1-5	X	X	X	X	
Offspring mixed						
To cages		L1-1	L1-2	L1-3	L1-4	L1-5

LOW 2

		Maternal Isofemale Line				
		L2-1	L2-2	L2-3	L2-4	L2-5
Paternal Isofemale Line	L2-1		X	X	X	X
	L2-2	X		X	X	X
	L2-3	X	X		X	X
	L2-4	X	X	X		X
	L2-5	X	X	X	X	
Offspring mixed						
To cages		L2-1	L2-2	L2-3	L2-4	L2-5

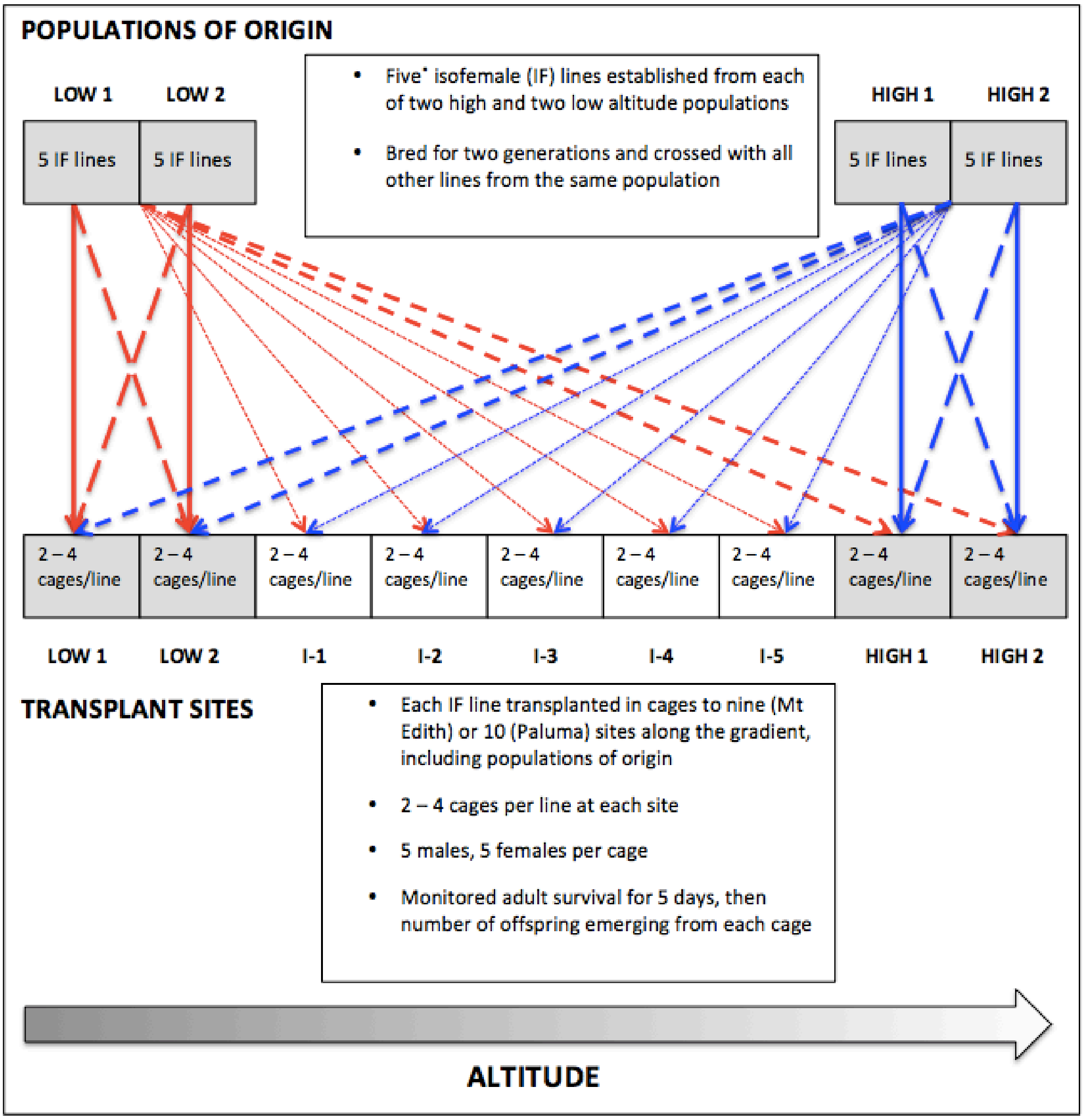
HIGH 1

		Maternal Isofemale Line				
		H1-1	H1-2	H1-3	H1-4	H1-5
Paternal Isofemale Line	H1-1		X	X	X	X
	H1-2	X		X	X	X
	H1-3	X	X		X	X
	H1-4	X	X	X		X
	H1-5	X	X	X	X	
Offspring mixed						
To cages		H1-1	H1-2	H1-3	H1-4	H1-5

HIGH 2

		Maternal Isofemale Line				
		H2-1	H2-2	H2-3	H2-4	H2-5
Paternal Isofemale Line	H2-1		X	X	X	X
	H2-2	X		X	X	X
	H2-3	X	X		X	X
	H2-4	X	X	X		X
	H2-5	X	X	X	X	
Offspring mixed						
To cages		H2-1	H2-2	H2-3	H2-4	H2-5

Figure S1. Laboratory crossing scheme to generate lines used in cage transplants from each of the four source populations from each gradient. Females from each of the (up to five) isofemale lines from each population were mated with males from each of the other lines from the same population, excluding crosses between flies from the same line. Each line cross combination was replicated three times. Offspring of females from the same isofemale line were then combined and used in the cage transplant experiment. There was substantial variation in the number of offspring generated by line combinations (see Table S4; Figure S3), therefore the number of lines available for transplant varied among populations and sites. Exact numbers of lines transplanted to each site are shown in the table within Figure S3.



Gradient	Site									
Mt Edith	**LOW 1**	**LOW 2**	**I-1**	**I-2**	**I-3**	**I-4**	**I-5**	**I-6**	**HIGH 1**	**HIGH 2**
Altitude (m)	697	702	724	785	815	928	1005	-	1020	1105
No. lines	15	13	9	9	9	9	9	-	14	14
No. cages	42	44	33	32	31	33	25	-	40	45
Paluma										
Altitude (m)	72	87	256	357	473	618	653	656	866	916
No. lines	19	19	7	8	7	6	7	8	18	18
No. cages	41	41	19	18	19	16	18	19	37	38

Figure S2. Schematic illustrating design of caged transplant experiment. Bold lines show transplants among the sites of origin: solid lines indicate transplants back into each population's home site; large dashed lines indicate transplants to the other site of origin at the same end of the gradient; and small dashed lines indicate transplants to the sites of origin at the opposite end of the gradient. Dotted lines indicate transplants to intermediate sites along the gradient (I-1 – I-5). Transplants originating from low altitude sites (LOW 1 and LOW 2) are in red, and from high altitude sites (HIGH 1 and HIGH 2) are in blue. To improve clarity, only one set of arrows depicts transplants from each end of the gradient to sites along the gradient, but lines from both populations of origin were transplanted in each case. At Paluma, only high altitude lines were transplanted to intermediate sites, but all lines were transplanted to sites at gradient ends. *The number of lines transplanted to each site varied because some lines did not produce sufficient offspring (see Methods). The table shows the exact number of lines and cages transplanted into each site at each of the two gradients.

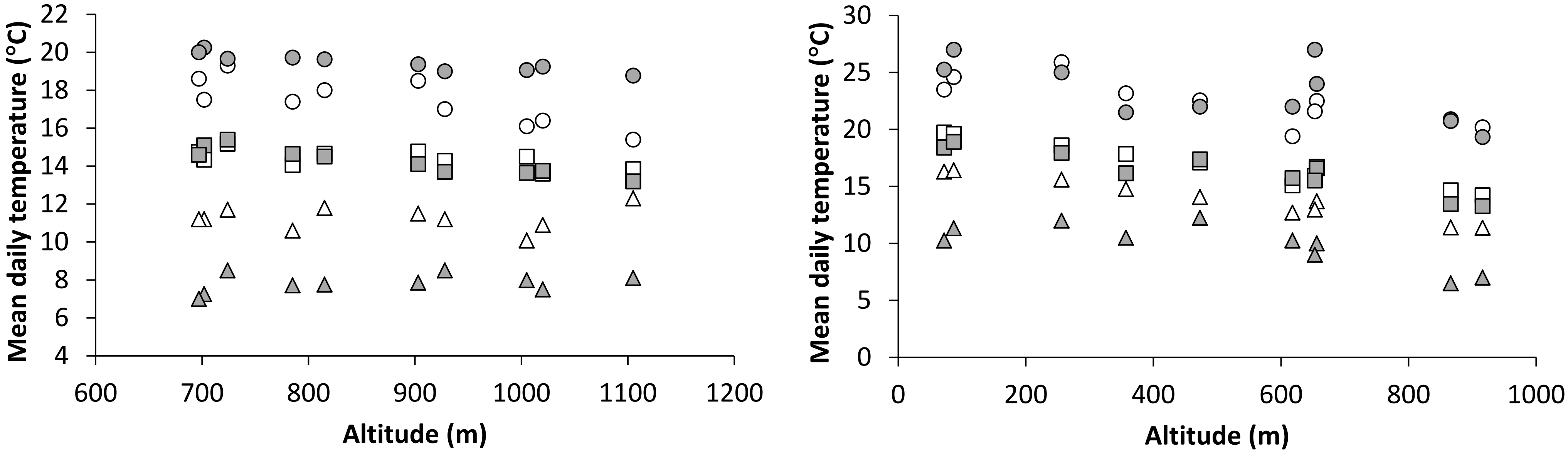


Figure S3. Comparison of temperatures measured inside field cages using iButtons (filled symbols) and outside cages at field sites using Tinytag Data Loggers (open symbols) along the two gradients where field transplant experiments were undertaken: Mt Edith (left) and Paluma (right). There was no significant difference between the estimates of mean daily temperature (MDT) (squares; t = -1.50, P = 0.142), or mean daily maximum temperature (MDT_{max})(circles; t = 0.367, P = 0.716) inside and outside cages, although mean daily minimum temperatures (MDT_{min}) measured using iButtons inside cages were lower than those measured outside cages using Data Loggers (triangles; t = -5.78, P = 1.37 x 10^{-6}). There was no significant difference between iButtons and Data Loggers in the change in temperature with respect to altitude for any of the three measures: MDT (t = 0.76, P = 0.452), MDT_{min} (t = 1.24, P = 0.222) or MDT_{max} (t = 0.86, P = 0.396).

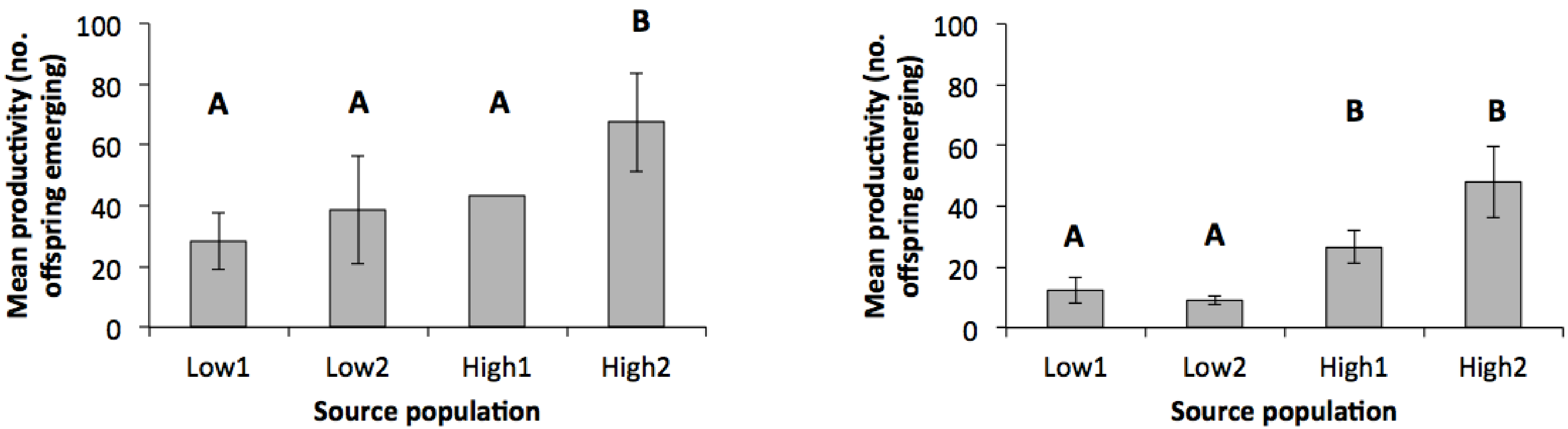


Figure S4. Mean productivity of each of the four source populations from Mt Edith (left) and Paluma (right) in laboratory crosses. Error bars are standard errors across mean productivities of the (up to five) lines within each source population. At one of the high altitude sites from Mt Edith (High1), only one of the five lines produced offspring in laboratory crosses. Different letters indicate significantly different productivity means of populations within a gradient.

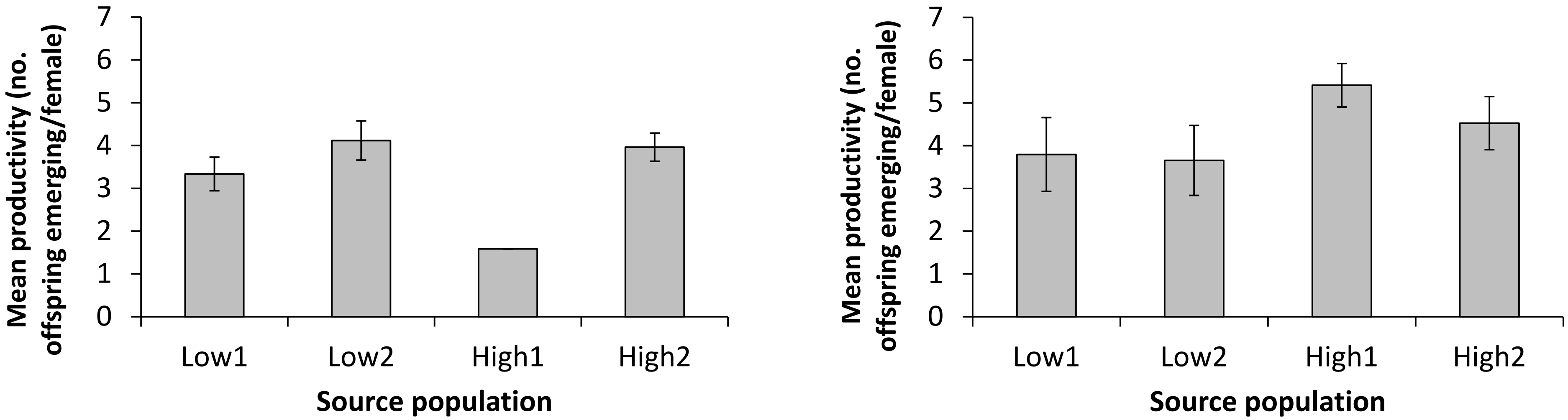


Figure S5. Mean productivity (estimated as the mean number of offspring per female) of each of the four source populations from Mt Edith (left) and Paluma (right) in cages transplanted to sites along altitudinal gradients. Productivities are averages across cages within and among sites for each source population. Error bars are standard errors across mean productivities of the (up to five) lines within each source population. At one of the high altitude sites from Mt Edith (High1), only one of the five lines produced offspring in laboratory crosses, therefore only a single line could be transplanted from this site. There was no significant difference among source populations at either gradient (see Table 2).