Supplementary File 1

Competition and resource depletion shape the thermal response of population fitness in *Aedes aegypti*

Supplementary Note 1

Method used to predict fecundity rate for matrix projection models (main text Equation 1)

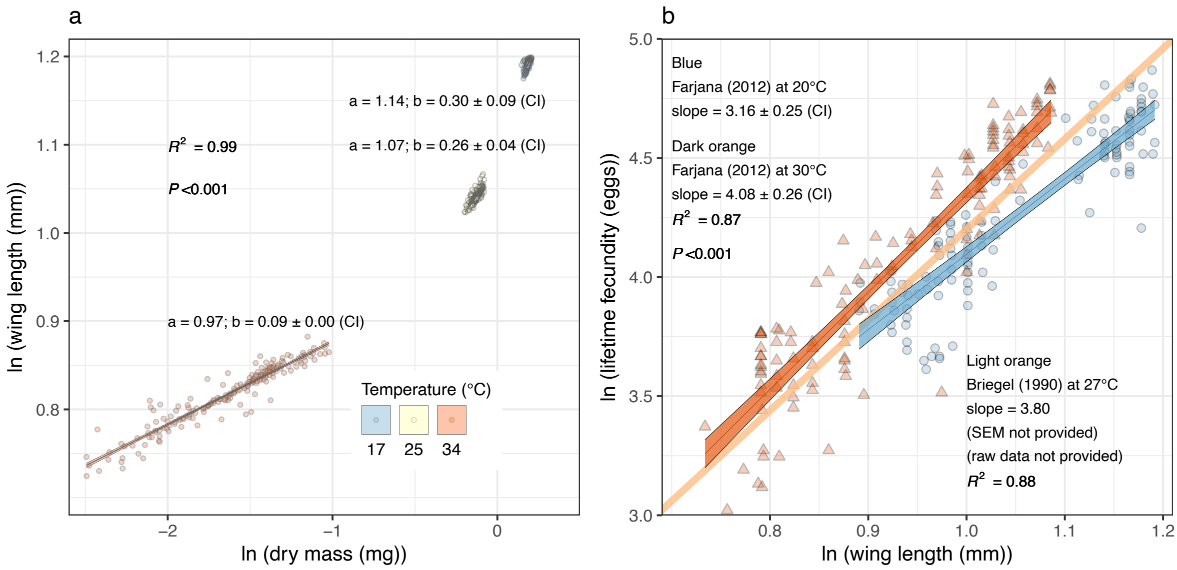
We measured each individual's dry mass to the nearest 0.01 mg using a microbalance. Prior to weighing, mosquitoes were dried individually in microcentrifuge tubes containing desiccant-silica gel for a minimum of 14 days. For the temperature-dependent scaling between mass and wing length, we analysed the van Heuvel [1] dataset. This showed that as temperatures increase from 25 to 34°C, the scaling between mass and wing length changes significantly (Supplementary Figure 1a). Our analysis of the Farjana [2] dataset indicated that the scaling between wing length and fecundity changes significantly with temperature but not resource level (Supplementary Figure 1b).

To estimate lifetime fecundity (*F* in Supplementary Equation 1) from mass for mosquitoes that we reared at 22°C at all food densities, we predicted wing length from mass using the mass-to-wing length exponent at 25°C in the van Heuvel [1] dataset. We used these wing lengths to predict fecundity using the wing length-to-fecundity scaling exponent from the Farjana [2] (n = 264, R^2 = 0.87, P<0.001; Supplementary Equation 1) dataset at their at 20°C.

For mosquitoes that we reared at 26°C, there is no corresponding temperature treatment in the Farjana [2] dataset, so we first predicted wing length from mass using the mass-to-wing length exponent at 25°C in the van Heuvel[1] dataset. We then predicted fecundity using the wing length-to-fecundity scaling from the Briegel[3] dataset at 27°C (n = 206, R^2 = 0.77, P<0.001; Supplementary Equation 1). For mosquitoes that we reared at 32 and 34°C, we predicted wing length from mass using the mass-to-wing length exponent at 34°C in the in the van Heuvel[1] dataset. We then predicted fecundity for these mosquitoes using the wing length-to-fecundity scaling exponent from the Farjana [2] (Supplementary Equation 1) dataset at 30°C. Fecundity was not estimated at 36°C, as no adults emerged at this temperature. The **scaling equations used to estimate temperature-dependent fecundity from wing length for our mosquitoes are:**

$$
\begin{aligned}
22°C,\ F &= 0.93 + 3.16 \log(L) \\
26°C,\ F &= 0.40 + 3.80 \log(L) \\
32°C,\ F &= 0.26 + 4.08 \log(L) \\
34°C,\ F &= 0.26 + 4.08 \log(L)
\end{aligned}
\qquad \text{(Supplementary Equation 1)}
$$

The coefficients were derived from our analysis (Supplementary Figure 1) of the Farjana [2] and Briegel [3] datasets.



Supplementary Figure 1. **a** Analysis of the van Heuvel [1] dataset shows that the scaling of mass and wing length in *Ae. Aegypti* is temperature-dependent. The scaling exponents (slopes) for 17°C and 25°C are significantly higher than at 34°C. However, the higher scaling exponent for 17°C is non-significantly higher than for 25°C. **b** Analysis of the Farjana [2] dataset shows that the scaling of wing length and fecundity in *Ae. Aegypti* is temperature-dependent. The scaling exponents (slopes) for both resource levels are significantly higher at 30°C than at 20°C. However, the effect of resource on fecundity is non-significant at the temperature level (not shown). The standard error for the scaling exponent at 27°C is not shown because it is not provided in [3], so for 26°C, we assumed a similar 95% CI to those in the Farjana [2] dataset (3.80 ± 0.25). Despite these assumptions relating to fecundity, our r_m calculations are robust to uncertainty/variation in the underlying scaling and temperature dependencies (Figure 4).

Model terms	Model name	AIC	ΔAIC	df
Temperature × RL	**Interaction**	**6446.77**	**0**	**20**
Temperature × RL + replicate + block	Maximal	6450.89	+4.12	23
Temperature × RL + replicate	No block	6448.89	+2.13	22
Temperature + RL	No interaction	6462.33	+15.56	8
Temperature	Temperature only	6481.32	+34.55	5
Resource	Resource only	6899.22	+452.46	4
None	Null	6906.62	+459.86	1

Supplementary Table 1. Simplification of the exponential juvenile survival model. The maximal model includes the effects of temperature × resource level (RL) + replicate + block on mortality. The final mortality model was obtained by dropping terms from the maximal model. If removing a term worsened model fit (ΔAIC > –2), then it was retained. Otherwise, it was removed. ΔAICs were calculated as differences from the interaction model (bold).

Resource level (mg ml^{-1})	Model name	AIC	df
0.183	Kamykowski [4]	–44.43	10
0.183	Lactin2 [5]	–42.77	11
0.367	Kamykowski [4]	–65.53	10
0.367	Lactin2 [5]	–67.77	11
0.550	Kamykowski [4]	–61.31	10
0.550	Lactin2 [5]	–63.61	11
0.733	Kamykowski [4]	–53.82	10
0.733	Lactin2 [5]	–56.40	11

Supplementary Table 2. Comparison of model fitting for r_m TPCs by resource level. We considered several models that allow for negative values at both cold and hot extremes, including polynomial regression models (quadratic models underfitted the matrix projection r_m estimates, whereas cubic models overfitted these estimates (not shown) and other TPC models (not shown) that are implemented in the rTPC [6] R package. Overall, the Lactin2 [5] function and Kamykowski [4] model best described the matrix projection estimates according to the Akaike Information Criterion (AIC). Although these models performed similarly according to their AICs, we chose the Kamykowski [4] model because it was better at describing the estimated r_m at our lowest resource level.

Supplementary References

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6. Padfield, D., O'Sullivan, H. & Pawar, S. rTPC and nls.multstart : A new pipeline to fit thermal performance curves in R. *Methods in Ecology and Evolution* **12**, 1138–1143 (2021).