

Intraspecific variation in thermal tolerance differs between tropical and temperate fishes

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Supplementary Methods and Results

- 1) Model selection approach:** to test differences in intraspecific variation in CT_{max} between two relevant latitudinal groups, habitat types, hemisphere effect and methodology effects.

PGLS models from the most complex to the simple one:

Model 1 : $\log_{10} \text{ S.D. } CT_{max} \sim \alpha_0 + \alpha_1 \text{ Latitudinal position} + \alpha_2 \text{ Habitat} + \alpha_3 \text{ delta Temperature} + \alpha_4 \text{ Hemisphere} + \alpha_5 \text{ Number of individuals used} + \alpha_6 \text{ mean } CT_{max} + \alpha_7 \text{ Latitudinal position} \times \text{delta Temperature} + \alpha_8 \text{ Latitudinal position} \times \text{Hemisphere} + \alpha_9 \text{ Latitudinal position} \times \text{Habitat} + \epsilon$

Model 2 : $\log_{10} \text{ S.D. } CT_{max} \sim \alpha_0 + \alpha_1 \text{ Latitudinal position} + \alpha_2 \text{ Habitat} + \alpha_3 \text{ delta Temperature} + \alpha_4 \text{ Hemisphere} + \alpha_5 \text{ Number of individuals used} + \alpha_6 \text{ mean } CT_{max} + \alpha_7 \text{ Latitudinal position} \times \text{delta Temperature} + \alpha_8 \text{ Latitudinal position} \times \text{Habitat} + \epsilon$

Model 3 : $\log_{10} \text{ S.D. } CT_{max} \sim \alpha_0 + \alpha_1 \text{ Latitudinal position} + \alpha_2 \text{ Habitat} + \alpha_3 \text{ delta Temperature} + \alpha_4 \text{ Hemisphere} + \alpha_5 \text{ Number of individuals used} + \alpha_6 \text{ mean } CT_{max} + \alpha_7 \text{ Latitudinal position} \times \text{delta Temperature} + \epsilon$

Model 4: $\log_{10} \text{ S.D. } CT_{max} \sim \alpha_0 + \alpha_1 \text{ Latitudinal position} + \alpha_2 \text{ Habitat} + \alpha_3 \text{ delta Temperature} + \alpha_4 \text{ Hemisphere} + \alpha_5 \text{ Number of individuals used} + \alpha_6 \text{ mean } CT_{max} + \epsilon$

Model 5 : $\log_{10} \text{ S.D. } CT_{max} \sim \alpha_0 + \alpha_1 \text{ Latitudinal position} + \alpha_2 \text{ Habitat} + \alpha_3 \text{ delta Temperature} + \alpha_4 \text{ Hemisphere} + \alpha_5 \text{ Number of individuals used} + \epsilon$

Model 6: $\log_{10} \text{ S.D. } CT_{max} \sim \alpha_0 + \alpha_1 \text{ Latitudinal position} + \alpha_2 \text{ delta Temperature} + \alpha_3 \text{ Hemisphere} + \alpha_4 \text{ Number of individuals used} + \epsilon$

Model 7: $\log_{10} \text{ S.D. } CT_{max} \sim \alpha_0 + \alpha_1 \text{ Latitudinal position} + \alpha_2 \text{ delta Temperature} + \alpha_3 \text{ Hemisphere} + \epsilon$

Model 8 : $\log_{10} \text{ S.D. } CT_{max} \sim \alpha_0 + \alpha_1 \text{ delta Temperature} + \alpha_2 \text{ Hemisphere} + \epsilon$

Model 9 : $\log_{10} \text{ S.D. } CT_{max} \sim \alpha_0 + \alpha_1 \text{ Hemisphere} + \epsilon$

Model 10 : $\log_{10} \text{ S.D. } CT_{max} \sim \alpha_0 + \epsilon$

Supplementary Table 1: PGLS model selection approach by AIC function on 203 fish species.
Selected model is model 1 due to lowest AIC value.

N species	Models	df	AIC	Δ AIC
203	Model 1	10	266.1	
	Model 2	9	266.5	-0.5
	Model 3	8	267.6	-1.5
	Model 4	7	278.8	-12.7
	Model 5	6	277.3	-11.2
	Model 6	5	276.7	-10.6
	Model 7	4	279.5	-13.4
	Model 8	3	286.9	-20.8
	Model 9	2	315.4	-49.3
	Model 10	1	344.5	-78.4

2) Phylogenetic informed analysis on intraspecific variation of CT_{max} in 203 species

Model 1 : $\log_{10} \text{S.D. CT}_{\max} \sim \alpha_0 + \alpha_1 \text{Latitudinal position} + \alpha_2 \text{Habitat} + \alpha_3 \text{delta Temperature} + \alpha_4 \text{Hemisphere} + \alpha_5 \text{Number of individuals used} + \alpha_6 \text{mean CT}_{\max} + \alpha_7 \text{Latitudinal position} \times \text{delta Temperature} + \alpha_8 \text{Latitudinal position} \times \text{Hemisphere} + \alpha_9 \text{Latitudinal position} \times \text{Habitat} + \epsilon$

Supplementary Table 2: PGLS model summary, $F_{9,192} = 4.452$, $\lambda = 0.430$, $R^2 = 17.27$, $p < 0.001$ on 203 fish species.

N species	coefficients	estimates	s.e.	t values	p values
203	Intercept	0.212	0.312	0.681	0.497
	Tropical species	-0.72	0.252	-2.844	0.005
	Marine species	-0.198	0.073	-2.700	0.008
	Δ Temperature	0.01	0.007	1.523	0.13
	Southern hemisphere	0.028	0.089	0.32	0.75
	Individuals	0.001	0.002	0.553	0.581
	CT _{max}	-0.015	0.007	-2.17	0.031
	Tropical sp* Δ Temperature	0.05	0.020	2.266	0.025
	Tropical*Southern hemisphere	0.201	0.127	1.58	0.116
	Tropical*Marine	0.243	0.115	2.116	0.036

FIGURES

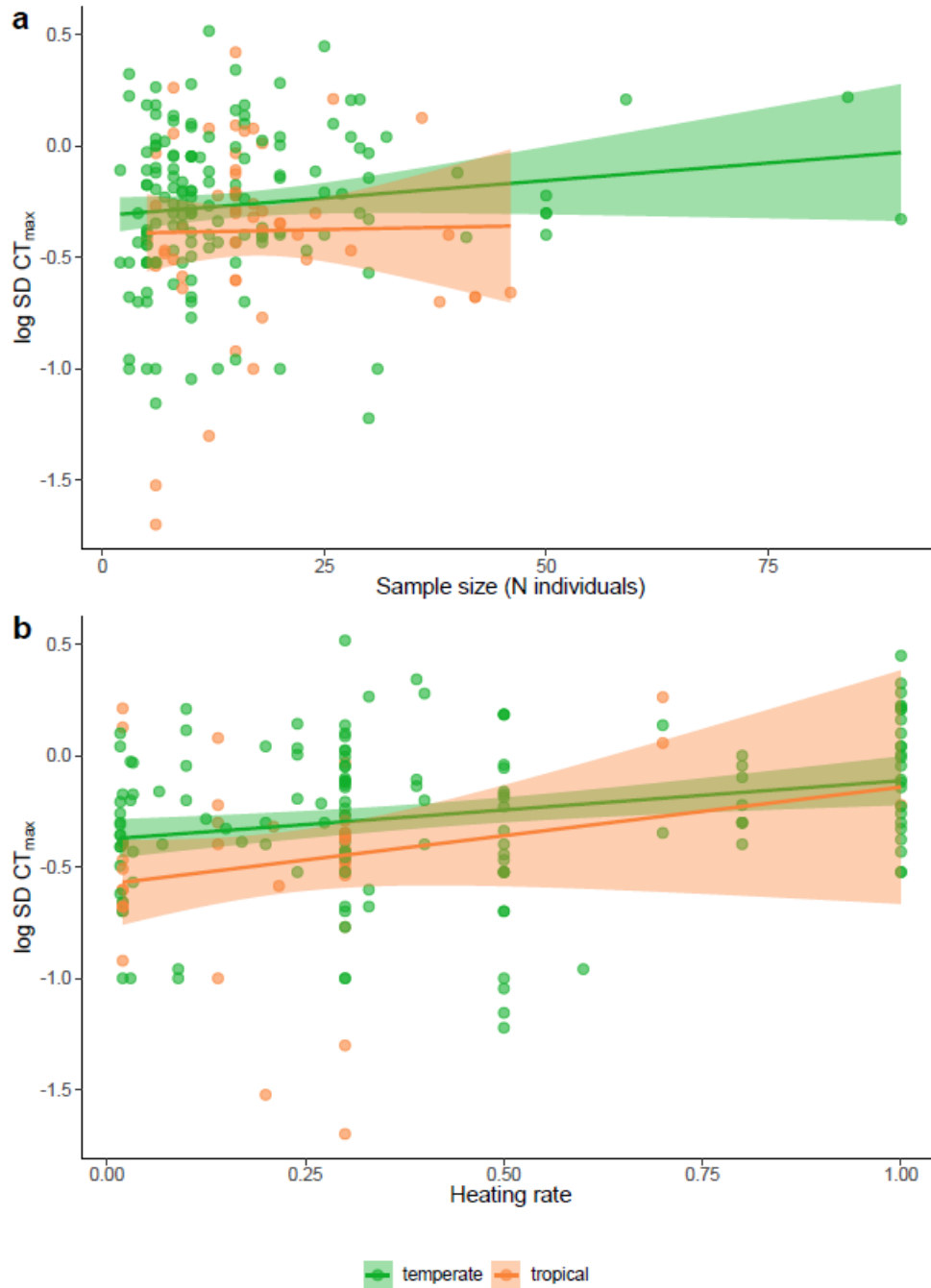


Figure S1 | The effect of (a) the number of individuals and (b) heating rate ($^{\circ}\text{C}/\text{min}$) used in each study on $\log_{10}$ transformed standard deviation of CT_{max} ($\log_{10}$ S.D. CT_{max}) divided by two latitudinal groups (tropical and temperate species). The shaded areas in the regression lines correspond to 95% of confidence interval.

3) GLM analysis on intraspecific variation CT_{max} in 203 species

Supplementary Table 3: GLM model summary on log₁₀ S.D.CT_{max}, $F_{9,193} = 5.347$, $R^2 = 19.96$ p < 0.001 in 203 fish species.

N species	coefficients	estimates	s.e.	t values	p values
203	Intercept	0.158	0.255	0.617	0.538
	Tropical species	-0.728	0.26	-2.840	0.005
	Marine species	-0.194	0.061	-3.153	0.0019
	Δ Temperature	0.011	0.007	1.581	0.115
	Southern Hemisphere	-0.028	0.089	-0.314	0.754
	Individuals	0.001	0.002	0.680	0.497
	CT _{max}	-0.016	0.006	-2.626	0.009
	Tropical sp*ΔTemperat ure	0.04	0.02	2.149	0.033
	Tropical*South ern hemisphere	0.274	0.131	2.100	0.037
	Tropical*Marin e	0.291	0.116	2.513	0.013

4) Phylogenetic informed analysis on intraspecific variation of CT_{max} in 186 species

Model 1 : $\log_{10}$ S.D. CT_{max} $\sim \alpha_0 + \alpha_1$ Latitudinal position + α_2 Habitat + α_3 delta Temperature + α_4 Hemisphere + α_5 Number of individuals used + α_6 mean CT_{max} + α_7 Heating rate (°C/min) + α_8 Latitudinal position x delta Temperature + ϵ 

Supplementary Table 4: PGLS model summary, $F_{10,174} = 4.242$, $\lambda = 0.427$, $R^2 = 19.6$, $p < 0.001$ on 186

fish species.

N species	coefficients	Estimates	s.e.	t values	p values
186	Intercept	0.247	0.32	0.773	0.441
	Tropical species	-0.75	0.263	-2.855	0.005
	Marine species	-0.175	0.074	-2.351	0.02
	Δ Temperature	0.005	0.008	0.631	0.529
	Southern Hemisphere	0.02	0.09	0.181	0.857
	Individuals	0.001	0.002	0.564	0.574
	CT _{max}	-0.016	0.007	-2.168	0.032
	Heating rate	0.203	0.083	2.433	0.016
	Tropical sp* Δ Temperature	0.055	0.021	2.678	0.008
	Tropical*Southern hemisphere	-0.018	0.187	-0.094	0.926

Tropical*Marine	0.127	0.14	0.911	0.363
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5) Supplementary Figures

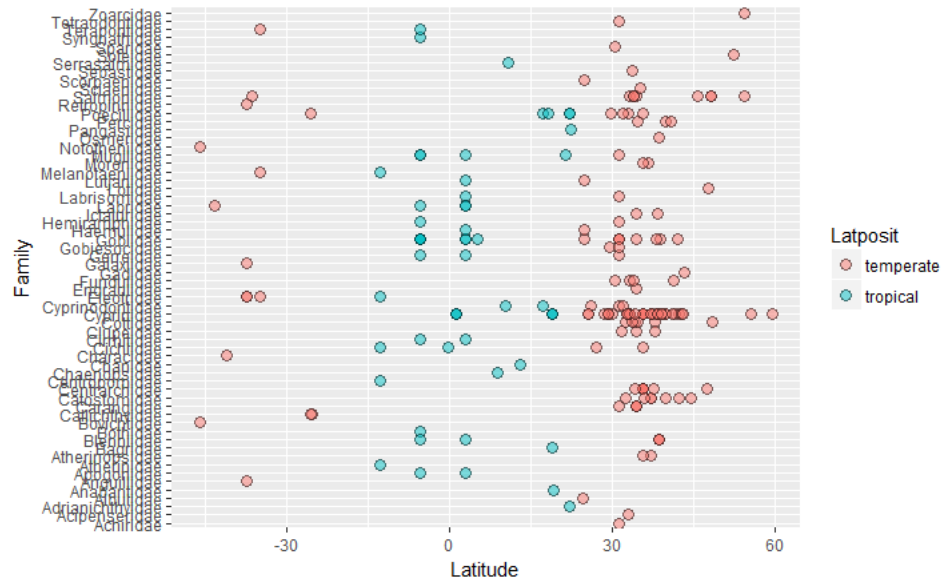


Figure S2| Representation of family across latitude divided in two latitudinal groups.
red dot temperate species, blue dots in tropical species.