**Supplementary material for**

**A widespread thermodynamic effect, but maintenance of biological rates through space across life’s major domains**

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**Figure S1. Relationship between mean temperature of the warmest quarter of the year (as a measure of Tenv, °C) and the optimum temperature (Topt, °C) for rates of development (d-1) and growth (% d-1), locomotion speed (cm s‑1), and rate of photosynthesis (mol m-2 s-1), respectively.** Solid lines depict significant relationships from phylogenetic mixed models testing for effects of Tenv on Topt (Tables S1-S4).

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**Figure S2. Relationship between mean temperature of the warmest quarter of the year (as a measure of Tenv, °C) and the natural log-transformed maximum rate (Umax) for rates of development (d-1) and growth (% d-1), locomotion speed (cm s-1), and rate of photosynthesis (mol m-2 s-1), respectively.** Statistical outcomes are provided in Tables S5-S8.

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**Figure S3. Relationship between mean temperature of the warmest quarter of the year (as a measure of Tenv, °C) and the natural log-transformed maximum rate (Umax) for rates of development (d-1) and growth (% d-1), locomotion speed (cm s-1), and rate of photosynthesis (mol m-2 s-1), respectively.** Data for growth rate are subdivided by Phylum because the data in Figure 3 conceal significant interactions between Phylum and Tenv.Solid lines depict significant relationships from phylogenetic mixed models testing for significant effects of Tenv on Umax. For presentation, only phyla with at least 30 measurements are plotted. Data points are presented as values adjusted for random effect of phylogeny; raw data are presented in Figure S4.

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**Figure S4. Relationship between mean temperature of the warmest quarter of the year (as a measure of Tenv, °C) and the natural log-transformed maximum rate (Umax) for rates of development (d-1) and growth (% d-1), locomotion speed (cm s-1), and rate of photosynthesis (mol m-2 s-1), respectively.** Data for growth rate are subdivided by Phylum because the data in Figure 3 conceal significant interactions between Phylum and Tenv. For presentation, only phyla with at least 30 measurements are plotted. Solid lines depict significant relationships from phylogenetic mixed models testing for significant effects of Tenv on Umax.

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**Figure S5. Relationship between optimum temperature (Topt, °C) and the natural log-transformed maximum rate (Umax) for rates of development (d-1) and growth (% d-1), locomotion speed (cm s-1), and rate of photosynthesis (mol m-2 s-1), respectively.** Solid lines depict significant relationships from phylogenetic mixed models testing for significant effects of Topt on Umax (Tables S9-S12).

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**Figure S6. Relationship between optimum temperature (Topt) and natural log-transformed maximum rate (umax) for rates of development (red, d-1) and growth (blue, % d‑1), locomotion speed (orange, cm s-1), and rate of photosynthesis (green), respectively.** Solid lines depict significant relationships from Table S15. Data for growth rate are subdivided by Phylum because the data in Figure 4 conceal significant interactions between Phylum and optimum temperature for growth. For presentation, only phyla with at least 30 measurements are plotted. Data points are presented as values adjusted for random effect of phylogeny and fixed effects as appropriate; raw data are presented in Figure S7.

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**Figure S7. Relationship between optimum temperature (Topt) and natural log-transformed maximum rate (umax) for rates of development (red, d-1) and growth (blue, % d‑1), locomotion speed (orange, cm s-1), and rate of photosynthesis (green), respectively.** Solid lines depict significant relationships from Table S15. Data for growth rate are subdivided by Phylum because the data in Figure 4 conceal significant interactions between Phylum and optimum temperature for growth. For presentation, only phyla with at least 30 measurements are plotted.

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**Figure S8. Relationship between the difference between optimum (Topt) and environmental temperature (Tenv), and a metric of seasonality calculated as the difference between the temperature of the warmest quarter and the temperature of the coolest quarter (°C) for rates of development (red, d-1) and growth (blue, % d-1), locomotion speed (orange, cm s-1), and rate of photosynthesis (green), respectively.** Seasonality is calculated as the difference between the temperature of the warmest quarter and the temperature of the coolest quarter. Solid lines depict significant relationships from Table S16. Data for locomotion speed are subdivided by substrate (terrestrial or aquatic) and Phylum because of significant interactions between substrate and Phylum (*F*3,154.9 = 3.45, p = 0.018) and between seasonality and Phylum (*F*1,85.0 = 21.9, p < 0.001). For presentation, only Phylum and method combinations with at least 30 measurements are plotted and so data are shown for chordates only, because there are no more than 16 records for each locomotion speed type for Arthropoda.

**Table S1. The relationship between optimum temperature for development rate (°C) and temperature of the warmest quarter (°C), a metric of seasonality calculated as the difference between the temperature of the warmest quarter and the temperature of the coolest quarter (°C), and body mass (mg).** Data were analysed using a phylogenetic mixed model with the significance of fixed effects calculated using Wald-type *F*-tests with conditional sums of squares and denominator degrees of freedom calculated according to Kenward and Roger (1)**.** Values in italics are the variance component estimates for the random effects and  is the proportion of variance, conditioned on the fixed effects, attributable to the random effect of phylogeny.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Estimate** | **SE** | **F (df)** | **p** |
| Intercept | 29.7 | 3.4 | 79.1 (1,11.4) | < 0.001 |
| ln(dry mass) | 0.48 | 0.18 | 7.10 (1,67.4) | 0.01 |
| Temp. warmest quarter | 0.075 | 0.031 | 5.89 (1,86.2) | 0.02 |
| Temp. seasonality | -0.022 | 0.026 | 0.73 (1,88.4) | 0.40 |
| *Species* | *4.30* | *1.08* |  |  |
| *Phylogeny* | *24.5* | *12.4* |  |  |
| *Residual* | *1.24* | *0.47* |  |  |
|  | 0.82 | 0.09 |  |  |

**Table S2 Relationship between optimum temperature for growth rate (°C) and temperature of the warmest quarter (°C) and a metric of seasonality calculated as the difference between the temperature of the warmest quarter and the temperature of the coolest quarter (°C).** Data were analysed using a phylogenetic mixed model with the significance of fixed effects calculated using Wald-type *F*-tests with conditional sums of squares and denominator degrees of freedom calculated according to Kenward and Roger (1). Values in italics are the variance component estimates for the random effects and  is the proportion of variance, conditioned on the fixed effects, attributable to the random effect of phylogeny.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Estimate** | **SE** | **F (df)** | **p** |
| Intercept | 24.5 | 4.5 | 27.0 (1,12.8) | < 0.001 |
| Temp. warmest quarter | 0.068 | 0.035 | 3.6 (1,129.4) | 0.06 |
| Temp. seasonality | -0.057 | 0.041 | 1.9 (1,127.2) | 0.17 |
| *Species* | *13.5* | *2.6* |  |  |
| *Phylogeny* | *92.1* | *38.2* |  |  |
| *Residual* | *3.69* | *0.73* |  |  |
|  | 0.84 | 0.07 |  |  |

**Table S3 Relationship between optimum temperature for locomotion speed (°C) and temperature of the warmest quarter (°C), a metric of seasonality calculated as the difference between the temperature of the warmest quarter and the temperature of the coolest quarter (°C), and body length (mm) for various measurements of locomotion speed (method: critical swim speed, running speed, sprint speed, sprint swim speed).** Data were analysed using a phylogenetic mixed model with the significance of fixed effects calculated using Wald-type *F*-tests with conditional sums of squares and denominator degrees of freedom calculated according to Kenward and Roger (1). Reference level for parameter estimates for the different methods used for estimating locomotion speed is critical swim speed. Values in italics are the variance component estimates for the random effects and  is the proportion of variance, conditioned on the fixed effects, attributable to the random effect of phylogeny.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Estimate** | **SE** | **F (df)** | **p** |
| Intercept | 38.2 | 10.4 | 12.9 (1,18.7) | 0.003 |
| ln(length) | -2.15 | 0.73 | 7.58 (1,124.9) | 0.007 |
| Temp. warmest quarter | 0.11 | 0.05 | 3.96 (1,153.6) | 0.048 |
| Temp. seasonality | -0.18 | 0.06 | 9.86 (1,135.6) | 0.002 |
| Method |  |  | 0.92 (3,141.6) | 0.43 |
| Method: Running speed | -0.67 | 2.03 |  |  |
| Method: Sprint speed | -2.36 | 2.87 |  |  |
| Method: Sprint swim speed | -2.00 | 1.75 |  |  |
| *Species* | *< 0.001* | *<0.001* |  |  |
| *Phylogeny* | *176.3* | *59.3* |  |  |
| *Residual* | *9.42* | *1.40* |  |  |
|  | 0.95 | 0.08 |  |  |

**Table S4 Relationship between optimum temperature for photosynthesis rate (°C) and temperature of the warmest quarter (°C) and a metric of seasonality calculated as the difference between the temperature of the warmest quarter and the temperature of the coolest quarter (°C).** Data were analysed using a phylogenetic mixed model with the significance of fixed effects calculated using Wald-type *F*-tests with conditional sums of squares and denominator degrees of freedom calculated according to Kenward and Roger (1). Values in italics are the variance component estimates for the random effects and  is the proportion of variance, conditioned on the fixed effects, attributable to the random effect of phylogeny.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Estimate** | **SE** | **F (df)** | **p** |
| Intercept | 24.4 | 28.6 | 0.73 (1,10.4) | 0.41 |
| Temp. warmest quarter | -0.056 | 0.078 | 0.51 (1,37.5) | 0.47 |
| Temp. seasonality | 0.13 | 0.10 | 1.63 (1,64.3) | 0.21 |
| *Species* | *3.36* | *4.54* |  |  |
| *Phylogeny* | *900.3* | *397.3* |  |  |
| *Residual* | *15.6* | *2.6* |  |  |
|  | 0.98 | 0.05 |  |  |

**Table S5. Relationship between natural log-transformed maximum development rate (d‑1) and temperature of the warmest quarter (°C), a metric of seasonality calculated as the difference between the temperature of the warmest quarter and the temperature of the coolest quarter (°C), and body mass (mg).** Data were analysed using a phylogenetic mixed model with the significance of fixed effects calculated using Wald-type *F*-tests with conditional sums of squares and denominator degrees of freedom calculated according to Kenward and Roger (1). Values in italics are the variance component estimates for the random effects and  is the proportion of variance, conditioned on the fixed effects, attributable to the random effect of phylogeny.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Estimate** | **SE** | **F (df)** | **p** |
| Intercept | -3.29 | 0.92 | 12.9 (1,15.8) | 0.002 |
| ln(dry mass) | -0.063 | 0.033 | 3.58 (1,97.9) | 0.06 |
| Temp. warmest quarter | 0.0044 | 0.0042 | 1.09 (1,50.9) | 0.30 |
| Temp. seasonality | 0.0001 | 0.0045 | 0.0008 (1,50.8) | 0.98 |
| *Species* | *0.099* | *0.025* |  |  |
| *Phylogeny* | *2.14* | *0.80* |  |  |
| *Residual* | *0.014* | *0.005* |  |  |
|  | 0.95 | 0.02 |  |  |

**Table S6 Relationship between natural log-transformed maximum growth rate (% d‑1) and temperature of the warmest quarter (°C) and a metric of seasonality calculated as the difference between the temperature of the warmest quarter and the temperature of the coolest quarter (°C).** Data were analysed using a phylogenetic mixed model with the significance of fixed effects calculated using Wald-type *F*-tests with conditional sums of squares and denominator degrees of freedom calculated according to Kenward and Roger (1). Values in italics are the variance component estimates for the random effects and  is the proportion of variance, conditioned on the fixed effects, attributable to the random effect of phylogeny.

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| --- | --- | --- | --- | --- |
| **Parameter** | **Estimate** | **SE** | **F (df)** | **p** |
| Intercept | 3.38 | 0.77 | 19.5 (1,19.6) | < 0.001 |
| Temp. warmest quarter | 0.0068 | 0.0078 | 0.76 (1,148.5) | 0.39 |
| Temp. seasonality | -0.0037 | 0.0091 | 0.16 (1,145.8) | 0.69 |
| *Species* | *0.61* | *0.11* |  |  |
| *Phylogeny* | *2.52* | *0.92* |  |  |
| *Residual* | *0.20* | *0.04* |  |  |
|  | 0.76 | 0.08 |  |  |

**Table S7 Relationship between natural log-transformed maximum locomotion speed (cm s-1) and temperature of the warmest quarter (°C), a metric of seasonality calculated as the difference between the temperature of the warmest quarter and the temperature of the coolest quarter (°C), and body or snout-vent length (mm) for various measurements of locomotion speed (method: critical swim speed, running speed, sprint speed, sprint swim speed).** Data were analysed using a phylogenetic mixed model with the significance of fixed effects calculated using Wald-type *F*-tests with conditional sums of squares and denominator degrees of freedom calculated according to Kenward and Roger (1). Reference level for parameter estimates for the different methods used for estimating locomotion speed is Critical swim speed. Values in italics are the variance component estimates for the random effects and  is the proportion of variance, conditioned on the fixed effects, attributable to the random effect of phylogeny.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Estimate** | **SE** | **F (df)** | **p** |
| Intercept | 1.65 | 0.97 | 6.18 (1,15.8) | 0.02 |
| ln(length) | 0.31 | 0.07 | 20.5 (1,128.5) | < 0.001 |
| Temp. warmest quarter | 0.016 | 0.005 | 9.77 (1,109.2) | 0.002 |
| Temp. seasonality | -0.021 | 0.005 | 16.5 (1,152.0) | < 0.001 |
| Method |  |  | 85.1 (3,109.2) | < 0.001 |
| Method: Running speed | -0.21 | 0.19 |  |  |
| Method: Sprint speed | 1.29 | 0.28 |  |  |
| Method: Sprint swim speed | 0.89 | 0.18 |  |  |
| *Species* | *0.051* | *0.018* |  |  |
| *Phylogeny* | *1.52* | *0.56* |  |  |
| *Residual* | *0.036* | *0.008* |  |  |
|  | 0.95 | 0.03 |  |  |

**Table S8 Relationship between natural log-transformed maximum photosynthesis rate (mol m-2 s-1) and temperature of the warmest quarter (°C) and a metric of seasonality calculated as the difference between the temperature of the warmest quarter and the temperature of the coolest quarter (°C).** Data were analysed using a phylogenetic mixed model with the significance of fixed effects calculated using Wald-type *F*-tests with conditional sums of squares and denominator degrees of freedom calculated according to Kenward and Roger (1). Values in italics are the variance component estimates for the random effects and  is the proportion of variance, conditioned on the fixed effects, attributable to the random effect of phylogeny.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Estimate** | **SE** | **F (df)** | **p** |
| Intercept | 2.45 | 3.10 | 0.62 (1,7.3) | 0.46 |
| Temp. warmest quarter | -0.010 | 0.010 | 1.05 (1,63.1) | 0.31 |
| Temp. seasonality | 0.023 | 0.012 | 3.86 (1,78.8) | 0.053 |
| *Species* | *0.19* | *0.08* |  |  |
| *Phylogeny* | *10.6* | *5.6* |  |  |
| *Residual* | *0.10* | *0.02* |  |  |
|  | 0.97 | 0.02 |  |  |

**Table S9. Relationship between natural log-transformed maximum development rate (d‑1) and optimum temperature for development (TOPT, °C), a metric of seasonality calculated as the difference between the temperature of the warmest quarter and the temperature of the coolest quarter (°C), and body mass (mg).** Data were analysed using a phylogenetic mixed model with the significance of fixed effects calculated using Wald-type *F*-tests with conditional sums of squares and denominator degrees of freedom calculated according to Kenward and Roger (1). Values in italics are the variance component estimates for the random effects and  is the proportion of variance, conditioned on the fixed effects, attributable to the random effect of phylogeny.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Estimate** | **SE** | **F (df)** | **p** |
| Intercept | -4.52 | 1.17 | 14.8 (1,26.8) | < 0.001 |
| ln(dry mass) | -0.069 | 0.032 | 4.45 (1,98.4) | 0.04 |
| TOPT | 0.044 | 0.013 | 11.4 (1,85.5) | 0.001 |
| Temp. seasonality | -0.0001 | 0.0032 |  |  |
| *Species* | *0.069* | *0.021* |  |  |
| *Phylogeny* | *3.19* | *1.01* |  |  |
| *Residual* | *0.012* | *0.004* |  |  |
|  | 0.98 | 0.01 |  |  |

**Table S10 Relationship between natural log-transformed maximum growth rate (% d‑1) and the optimal temperature for growth rate (TOPT, °C) and a metric of seasonality calculated as the difference between the temperature of the warmest quarter and the temperature of the coolest quarter (°C).** Data were analysed using a phylogenetic mixed model with the significance of fixed effects calculated using Wald-type *F*-tests with conditional sums of squares and denominator degrees of freedom calculated according to Kenward and Roger (1). Values in italics are the variance component estimates for the random effects and  is the proportion of variance, conditioned on the fixed effects, attributable to the random effect of phylogeny.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Estimate** | **SE** | **F (df)** | **p** |
| Intercept | 1.55 | 0.93 | 16.9 (1,24.4) | 0.08 |
| TOPT | 0.074 | 0.013 | 30.5 (1,205.9) | < 0.001 |
| Temp. seasonality | 0.003 | 0.009 | 0.13 (1,158.3) | 0.72 |
| *Species* | *0.42* | *0.09* |  |  |
| *Phylogeny* | *3.50* | *1.16* |  |  |
| *Residual* | *0.21* | *0.04* |  |  |
|  | 0.84 | 0.05 |  |  |

**Table S11 Relationship between natural log-transformed maximum locomotion speed (cm s-1) and the optimal temperature for locomotion speed (TOPT, °C), a metric of seasonality calculated as the difference between the temperature of the warmest quarter and the temperature of the coolest quarter (°C), and body or snout-vent length (mm) for various measurement of locomotion speed (method: critical swim speed, running speed, sprint speed, sprint swim speed).** Data were analysed using a phylogenetic mixed model with the significance of fixed effects calculated using Wald-type *F*-tests with conditional sums of squares and denominator degrees of freedom calculated according to Kenward and Roger (1). Reference level for parameter estimates for locomotion speed method is critical swim speed. Values in italics are the variance component estimates for the random effects and  is the proportion of variance, conditioned on the fixed effects, attributable to the random effect of phylogeny.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Estimate** | **SE** | **F (df)** | **p** |
| Intercept | 0.86 | 0.93 | 5.35 (1,17.7) | 0.03 |
| ln(length) | 0.36 | 0.07 | 28.6 (1,126.2) | < 0.001 |
| TOPT | 0.024 | 0.007 | 13.1 (1,145.3) | < 0.001 |
| Temp. seasonality | -0.012 | 0.004 | 7.28 (1,142.6) | 0.008 |
| Method |  |  | 74.8 (3,110.4) | < 0.001 |
| Method: Running speed | -0.24 | 0.18 |  |  |
| Method: Sprint speed | 1.27 | 0.26 |  |  |
| Method: Sprint swim speed | 0.88 | 0.17 |  |  |
| *Species* | *0.032* | *0.016* |  |  |
| *Phylogeny* | *1.41* | *0.50* |  |  |
| *Residual* | *0.046* | *0.010* |  |  |
|  | 0.95 | 0.02 |  |  |

**Table S12 Relationship between natural log-transformed maximum photosynthesis rate (mol m-2 s-1) and the optimal temperature for photosynthesis rate (TOPT, °C) and a metric of seasonality calculated as the difference between the temperature of the warmest quarter and the temperature of the coolest quarter (°C).** Data were analysed using a phylogenetic mixed model with the significance of fixed effects calculated using Wald-type *F*-tests with conditional sums of squares and denominator degrees of freedom calculated according to Kenward and Roger (1). Values in italics are the variance component estimates for the random effects and  is the proportion of variance, conditioned on the fixed effects, attributable to the random effect of phylogeny.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Estimate** | **SE** | **F (df)** | **p** |
| Intercept | 1.49 | 0.29 | 27.4 (1,96.1) | < 0.001 |
| TOPT | 0.033 | 0.008 | 14.8 (1,118.5) | < 0.001 |
| Temp. seasonality | 0.019 | 0.010 | 3.94 (1,61.5) | 0.051 |
| *Species* | *0.31* | *0.08* |  |  |
| *Phylogeny* | *< 0.001* | *< 0.001* |  |  |
| *Residual* | *0.13* | *0.02* |  |  |
|  | < 0.001 | < 0.001 |  |  |

**Table S13 Relationship between natural log-transformed maximum growth rate (% d‑1) and the optimal temperature for growth rate (TOPT, °C), a metric of seasonality calculated as the difference between the temperature of the warmest quarter and the temperature of the coolest quarter (°C), and Phylum.** Data were analysed using a phylogenetic mixed model with the significance of fixed effects calculated using Wald-type *F*-tests with conditional sums of squares and denominator degrees of freedom calculated according to Kenward and Roger (1). Variance component estimates (± standard error) for the random effects of Species, Phylogeny, and Residual are 0.22 ± 0.08, 2.08 ± 1.08, and 0.23 ± 0.04, respectively, and  = 0.82 ± 0.07 ( is the proportion of variance, conditioned on the fixed effects, attributable to the random effect of phylogeny).

|  |  |  |
| --- | --- | --- |
| **Term** | **F (df)** | **p** |
| Intercept | 2.74 (1,11.4) | 0.12 |
| TOPT | 37.6 (1,171.2) | < 0.001 |
| Temp. seasonality | 0.03 (1,172.5) | 0.86 |
| Phylum | 4.41 (13,18.6) | 0.002 |
| TOPT \* Phylum | 3.62 (9,146.1) | < 0.001 |

**Table S14 Relationship between natural log-transformed maximum locomotion speed (cm s-1) and the optimal temperature for locomotion speed (TOPT, °C), a metric of seasonality calculated as the difference between the temperature of the warmest quarter and the temperature of the coolest quarter (°C), phylum, body or snout-vent length (mm), and the method for locomotion speed (critical swim speed, running speed, sprint speed, sprint swim speed).** Data were analysed using a phylogenetic mixed model with the significance of fixed effects calculated using Wald-type *F*-tests with conditional sums of squares and denominator degrees of freedom calculated according to Kenward and Roger (1). Variance component estimates (± standard error) for the random effects of Species, Phylogeny, and Residual are 0.03 ± 0.01, 1.87 ± 0.63, and 0.03 ± 0.01, respectively, and  = 0.97 ± 0.01 ( is the proportion of variance, conditioned on the fixed effects, attributable to the random effect of phylogeny).

|  |  |  |
| --- | --- | --- |
| **Term** | **F (df)** | **p** |
| Intercept | 6.41 (1,18.7) | 0.02 |
| ln(length) | 23.0 (1,133.5) | < 0.001 |
| TOPT | 12.3 (1,125.1) | < 0.001 |
| Temp. seasonality (°C) | 12.9 (1,138.8) | < 0.001 |
| Method | 92.5 (3,104.6) | < 0.001 |
| Phylum | 0.16 (1,18.4) | 0.17 |
| TOPT \* Method | 3.20 (3,135.4) | 0.03 |
| TOPT \* Phylum | 9.01 (1,89.5) | 0.003 |
| Method \* Phylum | 0.40 (1,122.7) | 0.53 |

**Table S15. Parameter estimates for the relationship between natural log-transformed rates (umax) and optimum temperature Topt (°C), accounting for a metric of seasonality calculated as the difference between the temperature of the warmest quarter and the temperature of the coolest quarter (°C).** Because of significant interaction terms (Tables S13-S14) traits are subdivided by phylum for growth rates. Estimates provided are the parameter estimate ± se from a phylogenetic mixed model, which is also provided following conversion to a *Q*10 value, and p values were calculated using Wald-type *F*-tests with conditional sums of squares and denominator degrees of freedom calculated according to Kenward and Roger (1). Activation energy (Act. E. ± se) is converted from the parameter estimate for the relationship between natural log-transformed rates and inverse optimum temperature (K) (following 2).

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | Optimum temperature | | | |  |  |  |  | |
| Trait (rates/speed) | Phylum | n | Min. | Max | Estimate | se | *Q*10 | p | Act. E. | | se |
| Development |  | 118 | 20 | 39 | 0.044 | 0.013 | 1.55 | 0.001 | 0.35 | 0.10 | |
| Growth | Arthropoda | 76 | 15 | 35 | 0.049 | 0.017 | 1.64 | 0.006 | 0.38 | 0.13 | |
| Growth | Chlorophyta | 51 | 15 | 35 | 0.077 | 0.021 | 2.16 | 0.0006 | 0.59 | 0.16 | |
| Growth | Chordata | 35 | 12.2 | 32 | 0.059 | 0.030 | 1.80 | 0.064 | 0.44 | 0.22 | |
| Locomotion |  | 162 | 15 | 40.9 | 0.024 | 0.007 | 1.27 | 0.0004 | 0.18 | 0.05 | |
| Photosynthesis |  | 122 | 10.4 | 42.5 | 0.033 | 0.008 | 1.39 | 0.0002 | 0.23 | 0.07 | |

**Table S16. Parameter estimates for the relationship between the difference between optimum temperature Topt (°C) and mean temperature of the warmest quarter (°C), and a metric of seasonality calculated as the difference between the temperature of the warmest quarter and the temperature of the coolest quarter (°C).** Estimates provided are the parameter estimate ± se from a phylogenetic mixed model, with p-values calculated using Wald-type *F*-tests with conditional sums of squares and denominator degrees of freedom calculated according to Kenward and Roger (1).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Trait (rates/speed) | Phylum | Substrate | Estimate | se | p |
| Development |  |  | -0.04 | 0.08 | 0.58 |
| Growth |  |  | -0.15 | 0.08 | 0.08 |
| Locomotion | Chordata | Sprint speed | -0.38 | 0.09 | 0.00009 |
| Locomotion | Chordata | Sprint swim speed | -0.72 | 0.15 | 0.00002 |
| Photosynthesis |  |  | -0.43 | 0.15 | 0.006 |

**Table S17. Database for “A widespread thermodynamic effect, but maintenance of biological rates through space across life’s major domains”.** The database contains records of thermal relationships between locomotion speed and rates of development, growth and photosynthesis and temperature, where a clear maximal performance (optimum temperature) was identified across plants and animals. The database contains a designation to taxonomic group used for analysis (*taxgrp*) and well as full taxonomic information (*Kingdom*, *Phylum*, *Class*, *Order*, *Family*, *Genus*, *Species* and *Full species* names). Further, in case of changes to species name *Suggested synonym* is given. For each record the *Habitat type* is given as either Terrestrial, Freshwater or Marine. *T[opt]* reflect the temperature of maximal performance in centigrade, while *ArhT[opt]* is the inverse *T[opt]* [1/*kT[opt],* where k is Boltzmann’s constant and T[opt] is in absolute temperature (K)]. *u[max]* is the maximal performance of the trait in question, i.e. the performance at T[opt] and the associated *Measured trait* and the unit with which this trait was measured (*Unit of measured trait*). *Performance trait (for T[opt])* and *Performance trait (for u[max])* were used as input variables for analyses. The following columns gives *Dry mass*, *Wet body mass* and *Body size* (snout-vent length (SVL) for reptiles and anurans or body length (BL) for fish and invertebrates, respectively). Locomotion speed is given as *SVL/s or BL/s*. SVL and BL were obtained from the original literature or estimated from other sources when not available (described for each record in comment fields inserted). Dry mass estimates were sourced from the original literature when given, or inferred from length or fresh mass measured available using specific relationships given by Hodar (3) and Ganihar (4). In all cases the sources and relationships used to generate dry mass estimates are given in the database. *Reference for species origin* states how the origin was sourced or estimated (comment fields in in the database). *Latitude* and *Longitude* signifies origin of the population investigated and *Reference* the paper documenting the thermal relationship. Finally, three columns give the MODIS Land Surface Temperature dataset (MOD11C3 v6; doi:10.5067/MODIS/MOD11C3.006; 0.05° spatial resolution, January 2001 – December 2016) environmental temperatures used for analyses. The variables used were mean temperature of the warmest quarter (*MODIS\_bio10*) and mean temperature of the coldest quarter (*MODIS\_bio11*), the latter which only used to calculate seasonality (the difference between the mean temperature of the warmest quarter and the mean temperature of the coldest quarter, *MODIS\_seasonality*). The final column identifies the database records included (*TRUE*) or excluded (*FALSE*) from the analyses.

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