



Similar metabolic responses of co-occurring post-settlement mussels to temperature change despite distinct geographical distributions

Nel, Adel; Quaid, Christopher D. ; Duna, Olwethu O. ; Gimenez Noya, Luis; Porri, Francesca

Marine Biology

DOI:

[10.1007/s00227-022-04147-3](https://doi.org/10.1007/s00227-022-04147-3)

Published: 01/01/2023

Peer reviewed version

[Cyswllt i'r cyhoeddiad / Link to publication](#)

Dyfyniad o'r fersiwn a gyhoeddwyd / Citation for published version (APA):

Nel, A., Quaid, C. D., Duna, O. O., Gimenez Noya, L., & Porri, F. (2023). Similar metabolic responses of co-occurring post-settlement mussels to temperature change despite distinct geographical distributions. *Marine Biology*, 170(1), Article 2. <https://doi.org/10.1007/s00227-022-04147-3>

Hawliau Cyffredinol / General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
 - You may not further distribute the material or use it for any profit-making activity or commercial gain
 - You may freely distribute the URL identifying the publication in the public portal ?

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

1 **Similar metabolic responses of co-occurring post-settlement mussels to**
2 **temperature change despite distinct geographical distributions**

3 **Aldi Nel^{1,2*}, Christopher D. McQuaid², Olwethu O. Duna^{1,2}, Luis Giménez^{3,4}, Francesca**
4 **Porri^{1,2}**

5 ¹ South African Institute for Aquatic Biodiversity, Private Bag 1015, 6140 Grahamstown,
6 South Africa

7 ² Department of Zoology and Entomology, Rhodes University, 6140 Grahamstown, South
8 Africa

9 ³Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Biologische
10 Anstalt Helgoland, Helgoland, Germany

11 ⁴ School of Ocean Sciences, Bangor University, Anglesey, United Kingdom

12 *Corresponding author: aldipieterse1@gmail.com

13

14 **Supplementary material:**

15 Table S1: The model selection process is displayed for each comparison for the variables size-corrected oxygen consumption (MO_2) in response
 16 to species (Sp), temperature (T) and month (M). The model best explaining respiration rate (bold and underlined) was selected based on the
 17 lowest Akaike's information criterion (AIC) value for stepwise exclusion of interaction terms. A “**” denotes both a plus (+) and an interaction
 18 (x) sign. For Species and -5 °C, significant interactions occurred for Sp x M (ANOVA; $F = 35.6$, $p < 0.001$) and Sp x T ($F = 6.7$, $p = 0.01$) in
 19 model 1, but the effect of species was not significant for model 5 ($F = 0.0$, $p = 1.0$). For Species and +5 °C, significant interactions occurred for
 20 Sp x M ($F = 35.56$, $p < 0.001$) and Sp x T ($F = 5.0$, $p = 0.01$) in model 1, but the effect of species was not significant ($F = 0.0$, $p = 1.0$) for model
 21 2.

Species and -5 °C	Species and +5 °C
1. m1: $gls(MO_2 \sim Sp * T * M)$ (AIC: 89.87)	1. m1: $gls(MO_2 \sim Sp * T * M)$ (AIC: 117.29)
2. m2: $gls(MO_2 \sim Sp + T + M + Sp \times T + Sp \times M + T \times M)$ (AIC: 88.03)	2. <u>m2: $gls(MO_2 \sim Sp + T + M + Sp \times T + Sp \times M + T \times M)$ (AIC: 119.97)</u>
3. m31: $gls(MO_2 \sim Sp + T + M + Sp \times M + T \times M)$ (AIC: 89.76)	3. m31: $gls(MO_2 \sim Sp + T + M + Sp \times M + T \times M)$ (AIC: 132.31)
4. m32: $gls(MO_2 \sim Sp + T + M + Sp \times T + T \times M)$ (AIC: 120.62)	4. m32: $gls(MO_2 \sim Sp + T + M + Sp \times T + T \times M)$ (AIC: 174.74)
5. <u>m33: $gls(MO_2 \sim Sp + T + M + Sp \times T + Sp \times M)$ (AIC: 86.94)</u>	5. m33: $gls(MO_2 \sim Sp + T + M + Sp \times T + Sp \times M)$ (AIC: 148.72)
6. m4: $gls(MO_2 \sim Sp + T + M)$ (AIC: 122.89)	6. m4: $gls(MO_2 \sim Sp + T + M)$ (AIC: 191.73)

22 Table S1 continued: The “ \dagger ” indicates significant T x M interactions (ANOVA, $p < 0.001$).

<i>Mytilus</i> and -5 °C	<i>Mytilus</i> and +5 °C
1. <u>m1: gls($MO_2 \sim T + M + T \times M^\dagger$) (AIC: 41.4)</u>	1. <u>m1: gls($MO_2 \sim T + M + T \times M^\dagger$) (AIC: 54.79)</u>
2. m2: gls($MO_2 \sim T + M$) (AIC: 71.3)	2. m2: gls($MO_2 \sim T + M$) (AIC: 67.46)
<i>Perna</i> and -5 °C	<i>Perna</i> and +5 °C
1. m1: gls($MO_2 \sim T + M + T \times M$) (AIC: 120.77)	1. <u>m1: gls($MO_2 \sim T + M + T \times M^\dagger$) (AIC: 73.09)</u>
2. <u>m2: gls($MO_2 \sim T + M$) (AIC: 117.67)</u>	2. m2: gls($MO_2 \sim T + M$) (AIC: 108.38)

24 Table S2: The mean (\pm S.D.) mass-specific oxygen consumption rates ($\text{nmol O}_2 \text{ min}^{-1} \mu\text{g}^{-1}$) are displayed for each month and treatment with the
 25 mean (\pm S.D.) animal lengths (μm) in parentheses.

	<i>Mytilus</i>			<i>Perna</i>		
	+5 °C	Collection	-5 °C	+5 °C	Collection	-5 °C
May 18	0.0009 \pm 0.0007	0.0003 \pm 0.0003	0.0002 \pm 0.0003	0.001 \pm 0.0009	0.0005 \pm 0.0006	
	(744.1 \pm 297.1)	(859.2 \pm 544.8)	(635.0 \pm 130.3)	(660.0 \pm 240.5)	(605.3 \pm 185.6)	
Jul 18	0.0015 \pm 0.001	0.0009 \pm 0.0005	0.0004 \pm 0.0003	0.001 \pm 0.0004	0.001 \pm 0.001	
	(741.9 \pm 281.2)	(752.8 \pm 213.1)	(763.4 \pm 248.5)	(574.2 \pm 141.5)	(681.4 \pm 307.1)	
Oct 18	0.0004 \pm 0.0004	0.0003 \pm 0.0002	0.0003 \pm 0.0002	0.0002 \pm 0.0002	0.0002 \pm 0.0003	0.0002 \pm 0.0001
	(1070.1 \pm 385.5)	(1085.1 \pm 396.5)	(958.0 \pm 237.8)	(1443.6 \pm 252.3)	(1652.8 \pm 376.2)	(1309.7 \pm 201.6)
Dec 18	0.002 \pm 0.001	0.001 \pm 0.0006	0.0009 \pm 0.0006	0.003 \pm 0.003	0.001 \pm 0.001	0.0009 \pm 0.001
	(638.0 \pm 184.3)	(627.5 \pm 223.4)	(682.9 \pm 196.0)	(555.6 \pm 85.8)	(674.3 \pm 187.0)	(664.1 \pm 177.6)
Jan 19				0.003 \pm 0.001	0.0004 \pm 0.0005	0.0002 \pm 0.0002
				(1207.7 \pm 230.0)	(1542.0 \pm 300.2)	(1708.1 \pm 354.5)

R scripts:

Size correction

The MO_2 response variable was adjusted for the size covariate by fitting a GLS model ($\text{Species1\$fitted}$) with the covariate ($\log MO_2 \sim \log \text{Dry Mass}$) (step 1), and by generating a new corrected MO_2c response variable from the residuals ($\text{Species1\$log } MO_2c <- \text{Species1\$log } MO_2 - \text{Species1\$fitted}$) (step 2).

Pairwise comparisons of MO_2 between species and temperatures for different months

Post-hoc Tukey HSD test-95 % family-wise confidence levels for interaction ANOVA models ($\text{aov}(\log MO_2c \sim \text{Temp} * \text{Month} * \text{Species})$) corresponding to the full GLS model (Table S1) were performed.