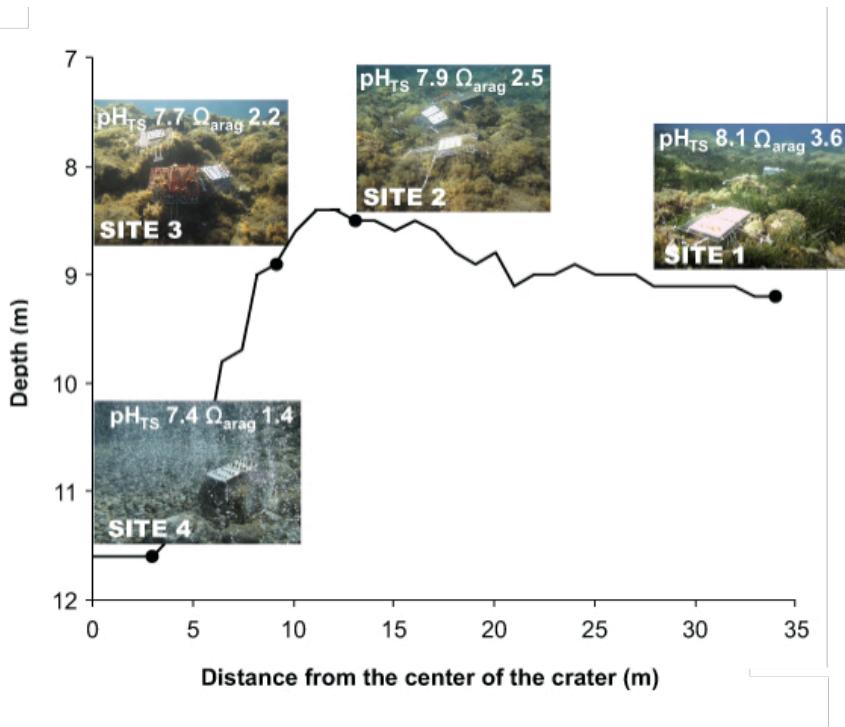


## SUPPLEMENTARY INFORMATION

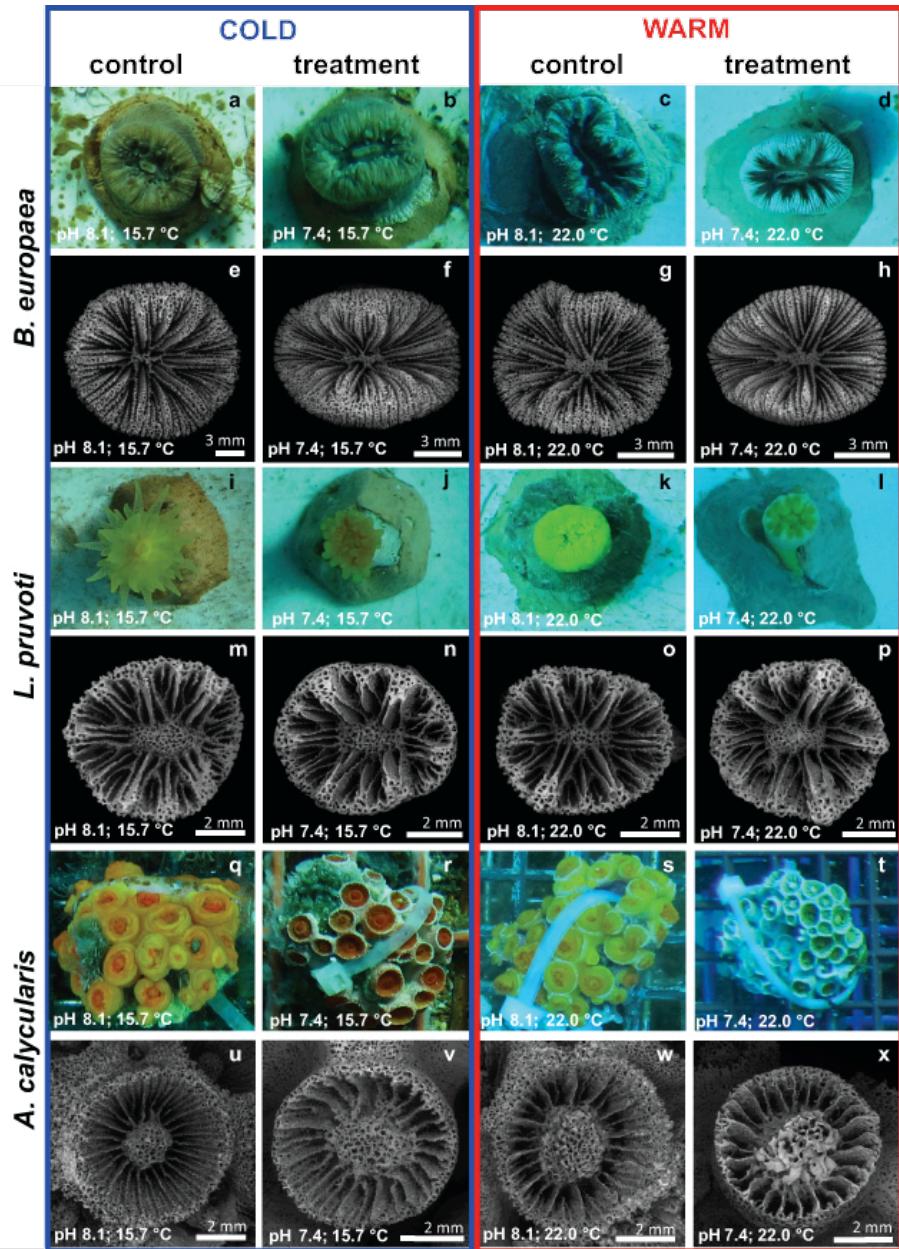
### Ocean warming and acidification synergistically increase coral mortality

F. Prada, E. Caroselli, S. Mengoli, L. Brizi, P. Fantazzini, B. Capaccioni, L. Pasquini, K. E. Fabricius, Z. Dubinsky, G. Falini, S. Goffredo

### SUPPLEMENTARY FIGURES

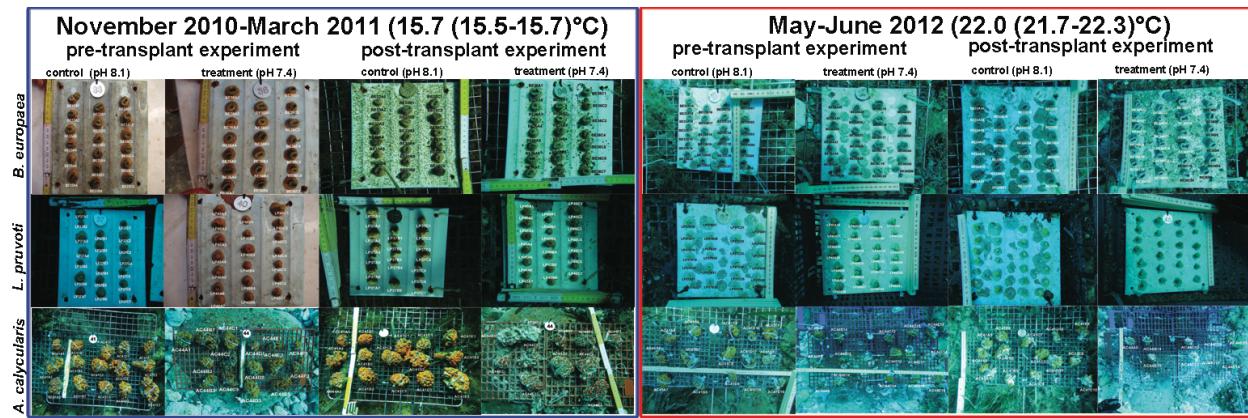


**Fig. S1. Bathymetric profile of the four sites.** Sites are shown in the pictures, with the associated mean  $\text{pH}_{\text{TS}}$  and  $\Omega_{\text{arag}}$ .



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14 **Fig. S2. Images of the three coral species under different pH and temperature conditions.** a-d, i-l, q-t:  
 15 Pictures of live *B. europaea*, *L. pruvoti*, and *A. calycularis* specimens. e-h, m-p, u-x: Low magnification  
 16 SEM images of coral skeletons (image courtesy of J.C. Weaver at Harvard University). Images are reported  
 17 for corals exposed to mean pH 8.1 and pH 7.4 in COLD (November 2010-March 2011; mean temperature:  
 18 15.7°C) and WARM (May-June 2012; mean temperature: 22.0°C) periods.  
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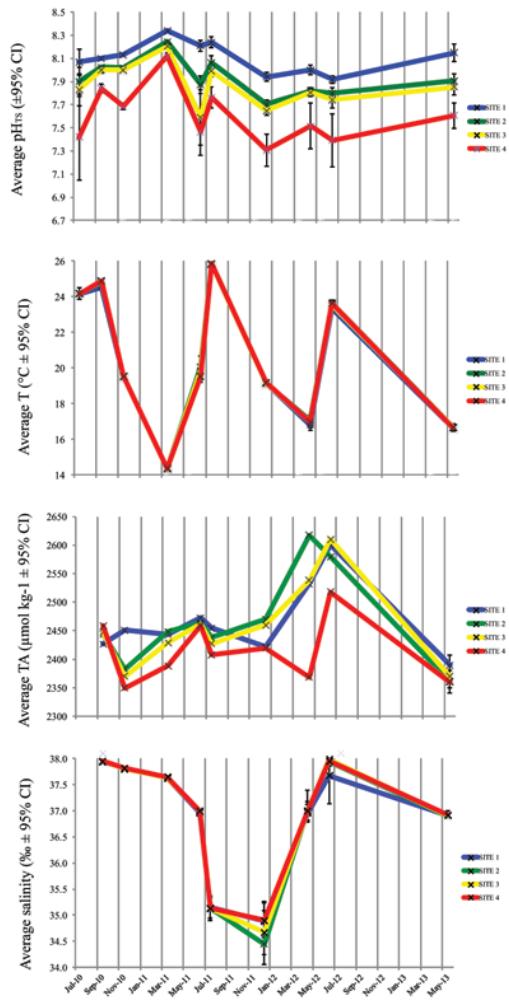


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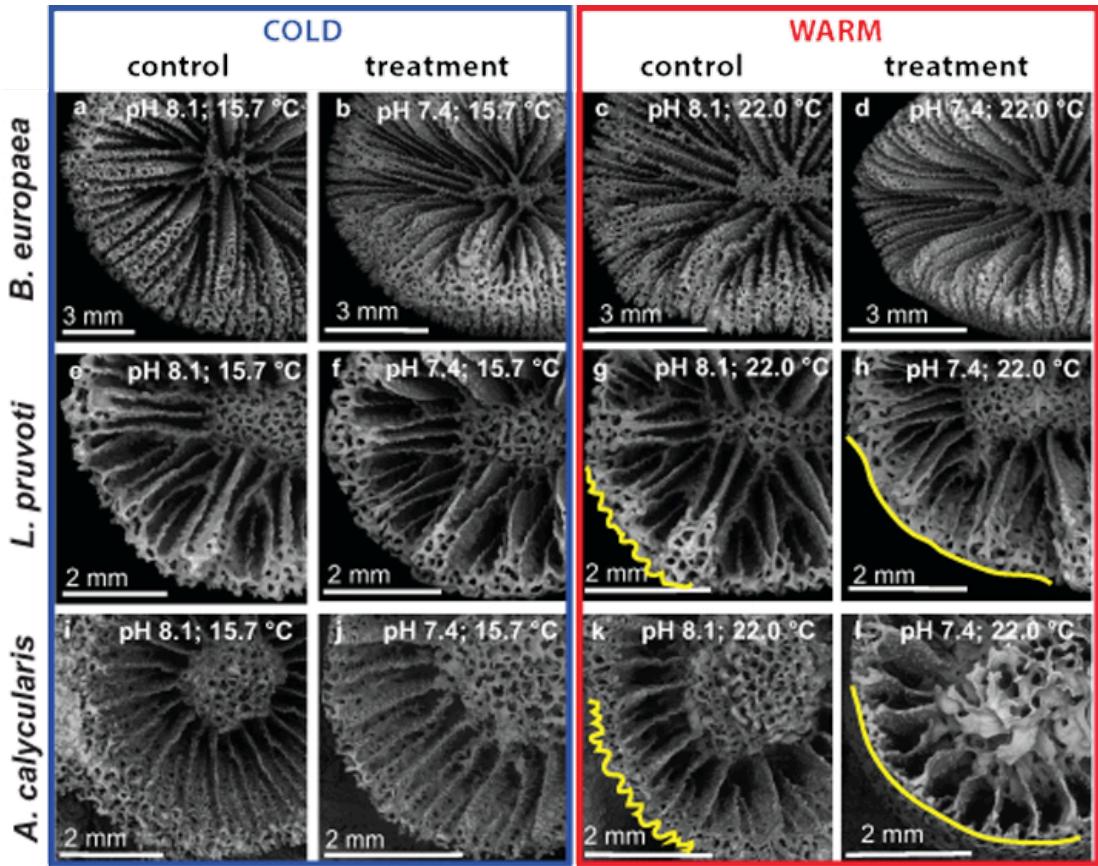
21 **Fig. S3. Pre and post experimental images for *B. europaea*, *L. pruvoti* and *A. calycularis* under different**  
 22 **pH and temperature conditions.** A few examples are given of specimens at the beginning and at the end of  
 23 transplant experiments in two representative transplant periods (COLD period in blue: November 2010-  
 24 March 2011; WARM period in red: May-June 2012) and two sites (control: pH<sub>TS</sub> 8.1; treatment: pH<sub>TS</sub> 7.4).

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28 **Fig. S4. Plots of average pH<sub>ts</sub>, temperature, total alkalinity and salinity as measured at the times of**  
29 **data collection at the experimental sites.** Average values and 95% confidence intervals were calculated  
30 from the related data reported in Table S1.  
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34 **Fig. S5. Low magnification SEM images of skeletons.** SEM images of skeletons of *Balanophyllia*  
 35 *europaea*, *Leptopsammia pruvoti* and *Astroides calycularis* specimens under different pH and temperature  
 36 conditions (image courtesy of J.C. Weaver at Harvard University). **a-d**, Images of *B. europaea*, **e-h**, *L.*  
 37 *pruvoti*, and **i-l**, *A. calycularis* skeletons. **g, k**, Yellow contour lines highlight rough and **h, l**, smooth surfaces  
 38 at mean pH 8.1 and pH 7.4, respectively, for *L. pruvoti* and *A. calycularis*. Images are reported for corals in  
 39 COLD (November 2010-March 2011; mean temperature: 15.7°C) and WARM (May-June 2012; mean  
 40 temperature: 22.0°C) periods.

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## SUPPLEMENTARY TABLES

Measured Parameters				
Treatment	pH range (total scale)	T (°C)	TA (μmol kg <sup>-1</sup> )	S (‰)
Site 1	8.07 (7.82-8.45)	20.5 (14.3-26.0)	2438 (2368-2600)	37 (33-38)
Site 2	7.87 (7.54-8.25)	20.7 (14.4-26.0)	2429 (2334-2618)	37 (33-38)
Site 3	7.74 (7.05-8.21)	20.6 (14.4-26.0)	2426 (2343-2610)	37 (34-38)
Site 4	7.40 (6.71-8.14)	20.6 (14.4-26.0)	2395 (2329-2518)	37 (34-38)
<b>Statistical significance</b>	***	NS	NS	NS

Calculated Parameters					
Treatment	*pCO <sub>2</sub> (μatm)	*HCO <sub>3</sub> <sup>-</sup> (μmol kg <sup>-1</sup> )	*CO <sub>3</sub> <sup>2-</sup> (μmol kg <sup>-1</sup> )	*DIC (μmol kg <sup>-1</sup> )	*Ω <sub>arag</sub>
Site 1	391 (127-780)	1869 (1466-2144)	232 (120-398)	2114 (1867-2291)	3.6 (1.8-6.3)
Site 2	672 (234-1561)	2030 (1664-2264)	163 (68-314)	2214 (1984-2383)	2.5 (1.1-5.0)
Site 3	907 (262-5100)	2073 (1835-2365)	144 (25-243)	2246 (2089-2552)	2.2 (0.4-3.9)
Site 4	1944 (306-7231)	2159 (1826-2355)	96 (16-233)	2317 (2070-2613)	1.4 (0.2-3.1)
<b>Statistical significance</b>	***	***	***	***	***

44 **Table S1. Seawater carbonate chemistry.** Measurements are shown for each study Site off the Island of Panarea. Site 1 is the reference and sites 2-4 are the elevated pCO<sub>2</sub> Sites. Temperature (T; n = 112-115 per site), pH (n = 103-110 per site) and salinity (S; n = 107-110 per site) were measured in July 2010, September 2010, November 2010, March 2011, June 2011, July-August 2011, November-December 2011, April-May 2012, June 2012 and May 2013. Total alkalinity (TA; n = 14 per site) was measured in September 2010, November 2010, March 2011, June 2011, July-August 2011, November-December 2011, April-May 2012, June 2012 and May 2013. pCO<sub>2</sub> = carbon dioxide partial pressure; HCO<sub>3</sub><sup>-</sup> = bicarbonate; CO<sub>3</sub><sup>2-</sup> = carbonate; DIC = dissolved inorganic carbon; Ω<sub>arag</sub> = aragonite saturation; NS = not significant; \*\*\*p<0.001, Kruskal-Wallis test. In brackets the min and max values.

MORTALITY RATE					
	Dec 2011-Apr 2012	Nov 2010-Mar 2011	Mar-Jun 2011	June-July 2011	July-Dec 2011
<i>B. europaea</i> polyp	9	12	12	12	12
<i>L. pruvoti</i> polyp		12	12	9	12
<i>A. calycularis</i> polyp		45	46	44	35
<i>A. calycularis</i> tissue		45	46	44	35
	NET CALCIFICATION RATE				
	Dec 2011-Apr 2012	Nov 2010-Mar 2011	Mar-Jun 2011	July-Dec 2011	
<i>B. europaea</i>	18	24	20	21	
<i>L. pruvoti</i>		21	21	22	
<i>A. calycularis</i>		20	15	12	

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65 **Table S2. Number of observations for each species and experimental period.**

66 For polyp mortality, number of tiles in *B. europaea* and *L. pruvoti*, and number of colonies in *A. calycularis*;  
67 for net calcification, number of polyps in *B. europaea* and *L. pruvoti*, and number of colonies in *A.*  
68 *calycularis*.

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20120128	14.8	20110112	15.3	20110430	15.9	20110927	23.6		20100910	24.6
20120128	14.8	20110112	15.3	20110430	15.8	20110927	23.7		20100910	24.6
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20120128	14.8	20110112	15.2	20110430	15.8	20110927	24.1		20100910	24.5
20120128	15.0	20110113	15.1	20110430	15.9	20110927	23.9		20100910	24.5
20120128	15.1	20110113	15.1	20110430	16.1	20110927	23.7		20100910	24.6
20120128	14.9	20110113	15.0	20110430	16.1	20110928	23.5		20100910	24.5
20120128	14.8	20110113	15.1	20110430	16.1	20110928	23.4		20100910	24.5
20120129	14.8	20110113	15.3	20110501	16.1	20110928	23.5		20100911	24.5
20120129	14.8	20110113	15.3	20110501	16.2	20110928	23.6		20100911	24.4
20120129	14.6	20110113	15.1	20110501	16.2	20110928	24.1		20100911	24.4
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20120129	14.9	20110114	15.1	20110501	16.3	20110928	23.8		20100911	24.4
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20120130	14.7	20110114	15.3	20110502	16.2	20110929	23.5		20100912	24.3
20120130	14.8	20110114	15.2	20110502	16.3	20110929	23.9		20100912	24.2
20120130	14.8	20110114	15.1	20110502	16.5	20110929	24.2		20100912	24.2
20120130	14.8	20110115	15.1	20110502	16.7	20110929	23.6		20100912	24.3
20120130	14.8	20110115	15.0	20110502	16.5	20110929	23.5		20100912	24.5
20120130	14.6	20110115	14.9	20110502	16.3	20110930	23.5		20100912	24.5
20120130	14.6	20110115	15.0	20110502	16.0	20110930	23.2		20100912	24.6
20120131	14.6	20110115	15.3	20110503	16.1	20110930	23.0		20100913	24.5
20120131	14.5	20110115	15.3	20110503	16.2	20110930	23.5		20100913	24.5
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20120201	14.6	20110116	15.2	20110504	16.2	20111001	23.7		20100914	24.5
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20120202	14.8	20110118	15.2	20110505	17.0	20111002	23.1		20100915	24.8
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20120202	14.7	20110118	15.0	20110505	16.4	20111003	22.9		20100915	24.9
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20120204	14.7	20110120	14.9	20110507	16.9	20111005	23.0			
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20120205	14.7	20110121	14.9	20110508	18.2	20111005	23.4			
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20120206	14.5	20110121	15.1	20110509	17.0	20111006	23.3			
20120206	14.5	20110121	15.1	20110509	17.1	20111006	23.8			
20120206	14.4	20110121	15.0	20110509	17.3	20111006	23.7			
20120206	14.5	20110122	14.9	20110509	17.5	20111006	23.4			
20120206	14.5	20110122	14.9	20110509	17.2	20111006	23.1			

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20120206	14.2	20110122	14.8	20110509	16.8	20111007	22.9		
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20120208	14.5	20110124	14.6	20110511	16.9	20111009	22.3		
20120209	14.4	20110124	14.7	20110512	16.9	20111009	22.3		
20120209	14.4	20110124	14.7	20110512	16.8	20111009	22.3		
20120209	14.4	20110124	14.8	20110512	16.6	20111009	22.2		
20120209	14.4	20110124	14.7	20110512	16.7	20111009	22.2		
20120209	14.6	20110125	14.6	20110512	16.9	20111009	21.9		
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20120210	14.3	20110125	14.8	20110513	16.9	20111010	21.2		
20120210	14.3	20110125	14.8	20110513	16.9	20111010	21.2		
20120210	14.3	20110125	14.7	20110513	17.0	20111010	21.3		
20120210	14.3	20110125	14.7	20110513	17.4	20111010	21.2		
20120210	14.3	20110126	14.4	20110513	18.1	20111010	20.9		
20120210	14.3	20110126	14.3	20110513	18.6	20111010	20.7		
20120210	14.3	20110126	14.5	20110513	18.0	20111011	20.4		
20120210	14.3	20110126	14.6	20110513	17.6	20111011	20.3		
20120211	14.3	20110126	14.7	20110514	17.4	20111011	20.5		
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20120427	17.9

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20120428	16.9										
20120428	17.5										
20120428	18.0										
20120428	18.3										
20120428	17.8										
<b>AVG</b>	<b>15.6</b>	<b>AVG</b>	<b>15.7</b>	<b>AVG</b>	<b>16.2</b>	<b>AVG</b>	<b>22.8</b>	<b>AVG</b>	<b>23.5</b>	<b>AVG</b>	<b>25.6</b>
<b>SD</b>	<b>1.2</b>	<b>SD</b>	<b>1.3</b>	<b>SD</b>	<b>1.7</b>	<b>SD</b>	<b>3.0</b>	<b>SD</b>	<b>1.7</b>	<b>SD</b>	<b>1.1</b>
<b>n</b>	<b>1177</b>	<b>n</b>	<b>860</b>	<b>n</b>	<b>728</b>	<b>n</b>	<b>934</b>	<b>n</b>	<b>408</b>	<b>n</b>	<b>520</b>
<b>95%</b>	<b>0.1</b>	<b>95%</b>	<b>0.1</b>	<b>95%</b>	<b>0.1</b>	<b>95%</b>	<b>0.2</b>	<b>95%</b>	<b>0.2</b>	<b>95%</b>	<b>0.1</b>
<b>CI</b>	<b>15.5</b>	<b>CI</b>	<b>15.6</b>	<b>CI</b>	<b>16.0</b>	<b>CI</b>	<b>22.6</b>	<b>CI</b>	<b>23.4</b>	<b>CI</b>	<b>25.5</b>
<b>CI</b>	<b>15.6</b>	<b>CI</b>	<b>15.7</b>	<b>CI</b>	<b>16.3</b>	<b>CI</b>	<b>23.0</b>	<b>CI</b>	<b>23.7</b>	<b>CI</b>	<b>25.7</b>

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93 **Table S3. At-depth temperature data for the six experimental transplant periods.** At-depth temperatures  
 94 were obtained from linear regression analysis between depth temperature, recorded by temperature sensors  
 95 placed in the sea bottom for almost 23 months (from June 3<sup>rd</sup> 2011 to April 25<sup>th</sup> 2013), and sea surface  
 96 temperature, recorded by mareographic stations close to Panarea Island using SM3810 (Society for  
 97 Environmental and Industrial monitoring; SIAP+MICROS) from the National Mareographic Network of the  
 98 Institute for the Environmental Protection and Research (ISPRA, available to <http://www.mareografico.it>)

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