Pansch et al. - supporting information

Supplementary tables

**Table S1:** Feeding treatments in cells per ml of *Chaetoceros calcitrans* and *Skeletonema costatum* (1:1 mixture) and in numbers of individuals of brine shrimp nauplii (*Artemia salina*). Total Carbon supply following Troedsson *et al*., 2005 (*C. calcitrans* = 4.6 ± 0.3 pg C cell-1), Granum *et al*., 2002 (*S. costatum* = 19 ± 4 pg C cell-1) and Hii *et al*., 2009 (*A. salina* nauplii = 0.905 μg C Ind-1).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | High-food | | Low-food | | High-food | Low-food |
| Week | Algae | Artemia | Algae | Artemia | C | |
|  | [cells ml-1] | [# of individuals] | [cells ml-1] | [# of individuals] | [µg] | |
| 0 | 64000 |  | 13000 |  | 2676 | 544 |
| 3 | 64000 | 3000 | 13000 | 600 | 5353 | 1087 |
| 4 | 64000 | 6000 | 13000 | 1200 | 8106 | 1630 |
| 5 |  | 11829 |  | 2403 | 10705 | 2175 |
| 6 |  | 20699 |  | 4200 | 18733 | 3801 |
| 7 |  | 29570 |  | 6000 | 26761 | 5430 |
| 8 |  | 38441 |  | 7688 | 34789 | 6958 |
| 9 |  | 44355 |  | 8871 | 40141 | 8028 |
| 10 |  | 59140 |  | 11828 | 53522 | 10704 |
| 11 |  | 65054 |  | 13011 | 58874 | 11775 |
| - |  | - |  | - | - | - |
| 20 |  | 65054 |  | 13011 | 58874 | 11775 |

**Table S2:** Water chemistry parameters for field and laboratory experiments (Kiel: June - October 2011, Tjärnö: August - September 2011; data are means ± s.d.).

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | In-situ measurements | | | | |  | Calculations | | | |
|  | *p*CO2 | T | Sal | pHNBS | pHT | CT |  | AT | pCO2 | ΩCa | ΩAr |
|  |  | [°C] |  |  |  | [µmol kg-1] |  | [µmol kg-1] | [µatm] |  |  |
| Kiel low-food | ambient | 19.5 ± 0.4 | 17.0 ± 1.8 | 8.06 ± 0.06 | 8.01 ± 0.08 | 1819.6 ± 98.1 |  | 1934.0 ± 114.6 | 453.6 ± 91.7 | 2.69 ± 0.52 | 1.62 ± 0.32 |
| moderate | 7.71 ± 0.05 | 7.72 ± 0.07 | 1907.1 ± 100.3 |  | 1943.7 ± 114.2 | 949.7 ± 158.3 | 1.46 ± 0.30 | 0.88 ± 0.19 |
| high | 7.19 ± 0.04 | 7.29 ± 0.04 | 2048.0 ± 107.7 |  | 1978.0 ± 106.4 | 2690.4 ± 253.6 | 0.56 ± 0.07 | 0.34 ± 0.04 |
| Kiel high-food | ambient | 8.12 ± 0.05 | 7.95 ± 0.08 | 1738.9 ± 155.9 |  | 1833.1 ± 174.6 | 499.0 ± 103.8 | 2.27 ± 0.60 | 1.37 ± 0.37 |
| moderate | 7.75 ± 0.04 | 7.68 ± 0.09 | 1817.9 ± 162.6 |  | 1846.9 ± 178.4 | 981.5 ± 181.1 | 1.31 ± 0.42 | 0.79 ± 0.26 |
| high | 7.21 ± 0.03 | 7.26 ± 0.05 | 1972.6 ± 154.0 |  | 1898.6 ± 158.3 | 2750.0 ± 304.6 | 0.52 ± 0.11 | 0.31 ± 0.07 |
| Kiel Fjord |  | 16.7 ± 1.4 | 16.8 ± 1.9 | 7.91 ± 0.26 | 7.86 ± 0.32 | 1965.4 ± 133.1 |  | 2025.1 ± 116.8 | 780.4 ± 990.2 | 1.89 ± 0.98 | 1.12 ± 0.60 |
| Kiel F1 larvae and juveniles | ambient | 20.2 ± 0.2 | 20.4 ± 0.3 | 8.18 ± 0.05 | 8.04 ± 0.02 | 2139.2 ± 64.0 |  | 2309.1 ± 69.1 | 461.2 ± 32.7 | 3.78 ± 0.27 | 2.32 ± 0.16 |
| moderate | 7.79 ± 0.05 | 7.77 ± 0.04 | 2291.8 ± 44.6 |  | 2367.7 ± 52.0 | 957.5 ± 91.7 | 2.22 ± 0.24 | 1.36 ± 0.15 |
| high | 7.25 ± 0.05 | 7.46 ± 0.07 | 2477.6 ± 86.6 |  | 2461.2 ± 94.6 | 2148.6 ± 322.1 | 1.18 ± 0.21 | 0.73 ± 0.13 |
| Tjärnö low-food | ambient | 19.7 ± 0.5 | 19.3 ± 4.0 | 8.12 ± 0.09 | 7.99 ± 0.05 | 2122.2 ± 301.1 |  | 2268.1 ± 347.5 | 526.4 ± 58.2 | 3.26 ± 0.89 | 2.02 ± 0.59 |
| moderate | 7.79 ± 0.12 | 7.66 ± 0.04 | 2087.6 ± 334.2 |  | 2122.2 ± 350.6 | 1141.7 ± 151.00 | 1.48 ± 0.39 | 0.91 ± 0.26 |
| high | 7.32 ± 0.04 | 7.23 ± 0.03 | 2265.6 ± 343.3 |  | 2179.3 ± 336.7 | 3255.9 ± 429.7 | 0.59 ± 0.13 | 0.36 ± 0.09 |
| Tjärnö high-food | ambient | 8.08 ± 0.08 | 7.93 ± 0.07 | 2064.8 ± 337.7 |  | 2182.8 ± 379.1 | 596.8 ± 98.6 | 2.76 ± 0.88 | 1.70 ± 0.57 |
| moderate | 7.80 ± 0.17 | 7.67 ± 0.04 | 2090.4 ± 380.9 |  | 2129.4 ± 395.4 | 1104.1 ± 193.1 | 1.54 ± 0.40 | 0.95 ± 0.26 |
| high | 7.32 ± 0.05 | 7.25 ± 0.03 | 2297.4 ± 326.9 |  | 2215.7 ± 319.5 | 3164.6 ± 421.0 | 0.62 ± 0.12 | 0.38 ± 0.08 |
| Tjärnö archipelago |  | 17.3 ± 1.3 | 20.9 ± 3.9 | 8.16 ± 0.10 | 8.05 ± 0.11 | 1849.1 ± 274.8 |  | 1994.7 ± 339.3 | 401.5 ± 65.1 | 3.13 ± 1.35 | 1.92 ± 0.86 |

**Table S3:** Effects of food and acidification over time on the response variables investigated in *Amphibalanus improvisus* from Kiel (p (MC) = p value after Monte Carlo correction). Statistically significant effects are in bold.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | N | Factor | d.f. | MS | Pseudo-F | p (MC) |
| Mortality | 8 | Food | 1 | 0.008 | 1.002 | 0.328 |
|  |  | Acidification | 2 | 0.017 | 2.067 | 0.139 |
|  |  | Food × Acidification | 2 | 0.002 | 0.202 | 0.818 |
| Size | 8 | Food | 1 | 10690.000 | 1219.600 | **<0.001** |
|  |  | Acidification | 2 | 1.719 | 0.196 | 0.954 |
|  |  | Time | 3 | 32684.000 | 3729.000 | **<0.001** |
|  |  | Food × Acidification | 2 | 2.307 | 0.263 | 0.913 |
|  |  | Food × Time | 3 | 1575.800 | 179.780 | **<0.001** |
|  |  | Acidification × Time | 6 | 2.579 | 0.294 | 0.993 |
|  |  | Food × Acidification × Time | 6 | 1.659 | 0.189 | 0.999 |
| Condition index | 8 | Food | 1 | 11715.000 | 71.205 | **<0.001** |
|  |  | Acidification | 2 | 103.540 | 0.629 | 0.688 |
|  |  | Time | 3 | 4053.900 | 24.640 | **<0.001** |
|  |  | Food × Acidification | 2 | 103.890 | 0.631 | 0.687 |
|  |  | Food × Time | 3 | 1097.500 | 6.671 | **<0.001** |
|  |  | Acidification × Time | 6 | 248.360 | 1.510 | 0.095 |
|  |  | Food × Acidification × Time | 6 | 118.260 | 0.719 | 0.768 |
| Dry weight | 8 | Food | 1 | 37365.000 | 406.160 | **<0.001** |
|  |  | Acidification | 2 | 41.894 | 0.455 | 0.898 |
|  |  | Time | 3 | 111760.000 | 1214.800 | **<0.001** |
|  |  | Food × Acidification | 2 | 50.600 | 0.550 | 0.817 |
|  |  | Food × Time | 3 | 28977.000 | 314.980 | **<0.001** |
|  |  | Acidification × Time | 6 | 56.805 | 0.617 | 0.930 |
|  |  | Food × Acidification × Time | 6 | 47.933 | 0.521 | 0.977 |
| Ash weight | 8 | Food | 1 | 34611.000 | 256.180 | **<0.001** |
|  |  | Acidification | 2 | 75.365 | 0.558 | 0.824 |
|  |  | Time | 3 | 112230.000 | 830.670 | **<0.001** |
|  |  | Food × Acidification | 2 | 121.090 | 0.896 | 0.507 |
|  |  | Food × Time | 3 | 27635.000 | 204.540 | **<0.001** |
|  |  | Acidification × Time | 6 | 80.282 | 0.594 | 0.953 |
|  |  | Food × Acidification × Time | 6 | 112.480 | 0.833 | 0.697 |
| Moulting frequency | 5 | Food | 1 | 217.270 | 0.713 | 0.389 |
|  |  | Acidification | 2 | 1860.000 | 6.104 | **0.002** |
|  |  | Food × Acidification | 2 | 124.400 | 0.408 | 0.666 |
| Reproduction (larval release) | 5 | Food | 1 | 19391.000 | 33.265 | **<0.001** |
|  |  | Acidification | 2 | 756.130 | 1.297 | 0.278 |
|  |  | Food × Acidification | 2 | 745.770 | 1.279 | 0.279 |
| Net-calcification rate | 6 | Food | 1 | 0.204 | 0.959 | 0.328 |
|  |  | Acidification | 2 | 2.745 | 12.904 | **<0.001** |
|  |  | Food × Acidification | 2 | 0.194 | 0.912 | 0.414 |
| Shell strength week 12 | 8 | Food | 1 | 85779000.000 | 226.870 | **<0.001** |
|  |  | Acidification | 2 | 91144.000 | 0.241 | 0.784 |
|  |  | Food × Acidification | 2 | 101990.000 | 0.270 | 0.765 |
| Shell strength week 20 | 8 | Food | 1 | 164220000.000 | 90.876 | **<0.001** |
|  |  | Acidification | 2 | 340220.000 | 0.188 | 0.829 |
|  |  | Food × Acidification | 2 | 851980.000 | 0.471 | 0.634 |
| F1 larval settlement | 6 | Food | 1 | 75.111 | 0.149 | 0.705 |
|  |  | Acidification | 2 | 287.440 | 0.568 | 0.574 |
|  |  | Food × Acidification | 2 | 591.510 | 1.170 | 0.319 |
| F1 juvenile growth | 4 | Food | 1 | 745.100 | 2.210 | 0.156 |
|  |  | Acidification | 2 | 0.683 | 0.002 | 0.998 |
|  |  | Food × Acidification | 2 | 465.050 | 1.379 | 0.277 |

**Table S4:** Effects of food and acidification over time on the response variables investigated in *Amphibalanus improvisus* from Tjärnö (p (MC) = p value after Monte Carlo correction). Statistically significant effects are in bold.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | N | Factor | d.f. | MS | Pseudo-F | p (MC) |
| Mortality | 6 | Food | 1 | 0.766 | 1.122 | 0.296 |
|  |  | Acidification | 2 | 6.012 | 8.812 | **0.001** |
|  |  | Food × Acidification | 2 | 0.068 | 0.099 | 0.909 |
| Size | 6 | Food | 1 | 5104.500 | 157.680 | **<0.001** |
|  |  | Acidification | 2 | 228.840 | 7.069 | **0.002** |
|  |  | Time | 2 | 1781.100 | 55.018 | **<0.001** |
|  |  | Food × Acidification | 2 | 34.863 | 1.077 | 0.345 |
|  |  | Food × Time | 2 | 135.920 | 4.199 | **0.013** |
|  |  | Acidification × Time | 4 | 40.598 | 1.254 | 0.294 |
|  |  | Food × Acidification × Time | 4 | 2.812 | 0.087 | 0.995 |
| Condition index | 6 | Food | 1 | 3362.700 | 25.296 | **<0.001** |
|  |  | Acidification | 2 | 91.542 | 0.689 | 0.525 |
|  |  | Time | 2 | 834.800 | 6.280 | **0.001** |
|  |  | Food × Acidification | 2 | 3.070 | 0.023 | 0.998 |
|  |  | Food × Time | 2 | 309.170 | 2.326 | 0.095 |
|  |  | Acidification × Time | 4 | 244.780 | 1.841 | 0.114 |
|  |  | Food × Acidification × Time | 4 | 107.200 | 0.806 | 0.547 |
| Dry weight | 6 | Food | 1 | 19093.000 | 43.984 | **<0.001** |
|  |  | Acidification | 2 | 700.430 | 1.614 | 0.133 |
|  |  | Time | 2 | 51230.000 | 118.020 | **<0.001** |
|  |  | Food × Acidification | 2 | 258.710 | 0.596 | 0.742 |
|  |  | Food × Time | 2 | 16732.000 | 38.545 | **<0.001** |
|  |  | Acidification × Time | 4 | 385.880 | 0.889 | 0.559 |
|  |  | Food × Acidification × Time | 4 | 619.410 | 1.427 | 0.144 |
| Ash weight | 6 | Food | 1 | 18360.000 | 43.025 | **<0.001** |
|  |  | Acidification | 2 | 708.770 | 1.661 | 0.130 |
|  |  | Time | 2 | 51338.000 | 120.310 | **<0.001** |
|  |  | Food × Acidification | 2 | 241.140 | 0.565 | 0.770 |
|  |  | Food × Time | 2 | 15950.000 | 37.378 | **<0.001** |
|  |  | Acidification × Time | 4 | 383.560 | 0.899 | 0.550 |
|  |  | Food × Acidification × Time | 4 | 599.910 | 1.406 | 0.152 |

**Supplementary figures**

**Figure S1:** Dry weight (**a, b**) and ash weight (**c, d**) of *Amphibalanus improvisus* from Kiel (left) and from Tjärnö (right) in the field (indicated by +) and at high and low food and ambient, moderate or high *p*CO2 (means ± 95% CIs; N=8 Kiel, N=6 Tjärnö; n.a. = not available). Significance of effects (PERMANOVA) is indicated by \* p<0.05, \*\* p<0.01, \*\*\* p<0.001 (Table S1, S2). Food treatments differ when they do not share a line connection (within weeks; PERMANOVA pair-wise tests at p < 0.05).

**Supplementary References**

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