Supplemental materials

Figure S1. Number of adult cleaner fish observed in the long-term cleaner fish removal experiment at Lizard Island. Dots are individual reef values and lines are means.

![Number of adult cleaner fish observed in the long-term cleaner fish removal experiment at Lizard Island. Dots are individual reef values and lines are means.](image)

Figure S2. Number of parasites attached to damselfish (mean ± std. error) according to cleaner presence and CO₂ treatment during the parasite infection assay.

![Number of parasites attached to damselfish (mean ± std. error) according to cleaner presence and CO₂ treatment during the parasite infection assay.](image)

Table S1. Seawater physicochemical parameters in all experimental setups (mean ± SE). Salinity, pH, temperature and alkalinity were measured daily over the 23 days of the experiment and averaged over the whole experimental period. The combination of total alkalinity (TA) and pH was used to calculate carbonate system.

| System | A1 | A2 | A3 | A4 | C1 | C2 | C3 | C4 |
|--------|----|----|----|----|----|----|----|----|
| **Measured** | | | | | | | | |
| Temp. (°C) | 24.8 ± 0.8 | 24.8 ± 0.8 | 24.8 ± 0.7 | 24.9 ± 0.7 | 24.7 ± 0.7 | 24.7 ± 0.8 | 24.7 ± 0.7 | 24.7 ± 0.8 |
| pH | 7.69 ± 0.04 | 7.67 ± 0.04 | 7.67 ± 0.04 | 7.67 ± 0.06 | 8.05 ± 0.02 | 8.06 ± 0.02 | 8.06 ± 0.02 | 8.06 ± 0.02 |
| TA (µmol/kgSW) | 2115.7 ± 15.3 | 2115.6 ± 15.1 | 2116.5 ± 15.2 | 2115.9 ± 16.5 | 2110.3 ± 12.9 | 2110.3 ± 12.9 | 2110.3 ± 12.9 | 2110.3 ± 12.9 |
| Salinity (ppt) | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| **Calculated** | | | | | | | | |
| TC (µmol/kgSW) | 1992.5 ± 23.2 | 1998.1 ± 18.9 | 2003.1 ± 23.5 | 2000 ± 26.6 | 1821.7 ± 17.1 | 1819.3 ± 17.2 | 1817.8 ± 16.4 | 1815.3 ± 18.4 |
| pCO₂ (µatm) | 938.1 ± 101 | 969 ± 84.5 | 1000.7 ± 106.2 | 990.8 ± 125.9 | 348.2 ± 20.1 | 343.8 ± 19 | 341.9 ± 19.7 | 338.3 ± 21.6 |
| Ω Arg | 1.59 ± 0.16 | 1.54 ± 0.13 | 1.51 ± 0.16 | 1.53 ± 0.21 | 3.15 ± 0.15 | 3.17 ± 0.15 | 3.19 ± 0.15 | 3.21 ± 0.17 |
**Table S2.** Analysis of deviance table (Type II tests) of mean number of parasites for CO₂ and cleaner presence treatment for generalized linear mixed-effects model (GLMM). Values mentioned in main text are italicized.

| Predictors      | χ²  | D.f. | p   | χ²  | D.f. | p   | χ²  | D.f. | p   | χ²  | D.f. | p   |
|-----------------|-----|------|-----|-----|------|-----|-----|------|-----|-----|------|-----|
| Cleaner         | 0.031 | 1    | 0.861 |
| CO₂             | 0.067 | 1    | 0.796 |
| Cleaner × CO₂   | 0.971 | 1    | 0.324 |

**Table S3.** Analysis of deviance table (Type II tests) of metabolic physiology measures [resting metabolic rate (ṀO₂Rest), maximum metabolic rate (ṀO₂Max), factorial aerobic scope (FAS) and absolute aerobic scope (AAS)] among CO₂ treatments, cleaner presence, and parasite infection for generalized linear mixed-effects models (GLMM). Values of p<0.05 are shown in bold. Values mentioned in main text are italicized.

| Predictors      | MO₂Rest | MO₂Max | FAS  | AAS  |
|-----------------|---------|--------|------|------|
| Cleaner         | 2.427   | 1      | 0.119 | 1.496 | 1 | 0.221 | 3.528 | 1 | 0.060 | 0.580 | 1 | 0.446 |
| CO₂             | 2.289   | 1      | 0.130 | 0.026 | 1 | 0.872 | 2.656 | 1 | 0.103 | 0.507 | 1 | 0.476 |
| Parasite        | 0.484   | 1      | 0.487 | 0.990 | 1 | 0.320 | 0.879 | 1 | 0.348 | 1.102 | 1 | 0.294 |
| Cleaner × CO₂   | 0.775   | 1      | 0.379 | 0.009 | 1 | 0.926 | 1.651 | 1 | 0.199 | 0.201 | 1 | 0.654 |
| Cleaner × Parasite | 0.108   | 1      | 0.743 | 11.390 | 1 | <0.001 | 2.976 | 1 | 0.085 | 11.414 | 1 | <0.001 |
| CO₂ × Parasite  | 0.924   | 1      | 0.337 | 1.332 | 1 | 0.248 | 6.959 | 1 | 0.008 | 1.718 | 1 | 0.190 |
| Cleaner × CO₂ × Parasite | 0.141   | 1      | 0.707 | 1.909 | 1 | 0.167 | 0.034 | 1 | 0.853 | 1.508 | 1 | 0.219 |
Table S4. Summary output for the post-hoc pairwise comparisons of metabolic physiology measures [maximum metabolic rate ($\dot{M}O_{2\text{Max}}$), factorial aerobic scope (FAS) and absolute aerobic scope (AAS)] among CO₂ treatments, cleaner presence and parasite infection. P-values were adjusted using tukey corrections. Values of p<0.05 are shown in bold. Yes = yes parasites, No = no parasites.

| Post-hoc comparison | $\dot{M}O_{2\text{Max}}$ | estimate | Std. error | t-ratio | p-value |
|---------------------|--------------------------|----------|------------|---------|---------|
| with cleaner, No - without cleaner, No | -0.194 | 0.162 | -1.198 | 0.630 |
| with cleaner, No - with cleaner, Yes | -0.567 | 0.177 | -3.197 | 0.011 |
| with cleaner, No - without cleaner, Yes | 0.045 | 0.158 | 0.287 | 0.992 |
| without cleaner No - with cleaner, Yes | -0.373 | 0.182 | -2.048 | 0.179 |
| without cleaner No - without cleaner, Yes | 0.240 | 0.158 | 1.518 | 0.432 |
| with cleaner, Yes- without cleaner, Yes | 0.613 | 0.182 | 3.369 | 0.006 |

| Post-hoc comparison | FAS | estimate | Std. error | t-ratio | p-value |
|---------------------|-----|----------|------------|---------|---------|
| Control, No - High CO₂, No | -0.071 | 0.026 | -2.759 | 0.035 |
| Control, No - Control, Yes | -0.029 | 0.015 | -1.929 | 0.224 |
| Control, No - High CO₂, Yes | -0.036 | 0.023 | -1.573 | 0.399 |
| High CO₂, No - Control, Yes | 0.042 | 0.027 | 1.557 | 0.409 |
| High CO₂, No - High CO₂, Yes | 0.035 | 0.022 | 1.630 | 0.368 |
| Control, Yes - High CO₂, Yes | -0.007 | 0.024 | -0.272 | 0.993 |

| Post-hoc comparison | AAS | estimate | Std. error | t-ratio | p-value |
|---------------------|-----|----------|------------|---------|---------|
| with cleaner, No - without cleaner, No | -0.397 | 0.247 | -1.603 | 0.383 |
| with cleaner, No - with cleaner, Yes | -0.857 | 0.269 | -3.191 | 0.011 |
| with cleaner, No - without cleaner, Yes | -0.043 | 0.230 | -0.185 | 0.998 |
| without cleaner No - with cleaner, Yes | -0.461 | 0.281 | -1.640 | 0.362 |
| without cleaner No - without cleaner, Yes | 0.354 | 0.244 | 1.449 | 0.473 |
| with cleaner, Yes - without cleaner, Yes | 0.815 | 0.266 | 3.063 | 0.015 |