

Niche acclimatization in Red Sea corals is dependent on flexibility of host-symbiont association

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Niche acclimatization in Red Sea corals is dependent on flexibility of host-symbiont association

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Supplement

Table S1. Data of abiotic variables. Measurements from water samples and CTD casts (N = 72) in the central Red Sea over sampling times (winter/ summer), sites (nearshore, midshore, offshore) and water depth (1, 5, 10, 20 m) given as means (standard errors in parentheses).

| season | site | depth (m) | temperature (°C) | light intensity ($\mu\text{mol photons m}^{-2} \text{s}^{-1}$) | O ₂ saturation (%) | salinity (practical salinity units) |
|--------|-----------|-----------|------------------|--|-------------------------------|-------------------------------------|
| summer | nearshore | 1 | 30.72 (0.14) | 1166.3 (37.2) | 88.44 (0.26) | 39.54 (0.02) |
| | | 5 | 30.68 (0.19) | 792.1 (45.4) | 88.79 (0.63) | 39.53 (0.02) |
| | | 10 | 30.35 (0.14) | 345.8 (88.9) | 87.62 (0.51) | 39.50 (0.02) |
| | | 20 | 29.60 (0.02) | 247.3 (68.2) | 82.83 (2.21) | 39.52 (0.06) |
| | midshore | 1 | 30.38 (0.19) | 1183.1 (35.3) | 90.08 (1.27) | 39.46 (0.04) |
| | | 5 | 30.22 (0.16) | 649.0 (92.4) | 90.51 (0.59) | 39.44 (0.04) |
| | | 10 | 30.04 (0.22) | 498.6 (120.7) | 89.81 (0.84) | 39.43 (0.04) |
| | | 20 | 29.03 (0.38) | 257.5 (65.9) | 89.38 (0.54) | 39.35 (0.05) |
| winter | offshore | 1 | 30.82 (0.09) | 1340.6 (108.3) | 89.35 (1.01) | 39.54 (0.10) |
| | | 5 | 30.61 (0.06) | 701.1 (117.6) | 89.13 (0.52) | 39.59 (0.06) |
| | | 10 | 30.43 (0.03) | 453.9 (57.4) | 88.78 (0.75) | 39.58 (0.04) |
| | | 20 | 29.21 (0.62) | 279.6 (18.7) | 89.43 (0.76) | 39.47 (0.01) |
| | nearshore | 1 | 25.92 (0.34) | 684.5 (2.39) | 96.04 (1.29) | 39.34 (0.05) |
| | | 5 | 25.64 (0.25) | 289.9 (82.4) | 95.95 (1.11) | 39.37 (0.04) |
| | | 10 | 25.61 (0.25) | 191.9 (17.7) | 95.80 (1.05) | 39.37 (0.03) |
| | | 20 | 25.51 (0.23) | 83.33 (10.0) | 94.01 (1.38) | 39.39 (0.02) |
| | midshore | 1 | 25.28 (0.40) | 963.6 (198.5) | 93.93 (0.92) | 39.42 (0.08) |
| | | 5 | 25.21 (0.38) | 476.4 (57.2) | 93.60 (1.06) | 39.46 (0.10) |
| | | 10 | 25.19 (0.36) | 333.5 (23.3) | 93.48 (0.97) | 39.46 (0.10) |
| | | 20 | 25.17 (0.36) | 152.3 (26.6) | 93.03 (1.22) | 39.46 (0.10) |
| | offshore | 1 | 24.97 (0.17) | 962.3 (130.) | 93.67 (0.13) | 39.49 (0.02) |
| | | 5 | 25.11 (0.35) | 414.3 (119.) | 94.40 (0.99) | 39.42 (0.08) |
| | | 10 | 25.08 (0.35) | 377.5 (41.3) | 94.47 (0.91) | 39.43 (0.08) |
| | | 20 | 24.97 (0.25) | 198.0 (30.9) | 94.30 (0.89) | 39.46 (0.06) |

Table S1 cont.

| season | site | depth (m) | chlorophyll <i>a</i> ($\mu\text{g l}^{-1}$) | turbidity (NTU) | silicate ($\mu\text{mol l}^{-1}$) | phosphate ($\mu\text{mol l}^{-1}$) |
|--------|-----------|--------------|--|-----------------|--|---|
| summer | nearshore | 1 | 0.262 (0.036) | 0.111 (0.005) | 0.387 (0.012) | 0.049 (0.002) |
| | | 5 | 0.261 (0.014) | 0.113 (0.007) | 0.323 (0.046) | 0.049 (0.002) |
| | | 10 | 0.261 (0.029) | 0.116 (0.003) | 0.362 (0.052) | 0.046 (0.010) |
| | | 20 | 0.488 (0.243) | 0.165 (0.006) | 0.747 (0.057) | 0.060 (0.010) |
| summer | midshore | 1 | 0.213 (0.036) | 0.107 (0.005) | 0.376 (0.018) | 0.060 (0.007) |
| | | 5 | 0.221 (0.029) | 0.111 (0.004) | 0.363 (0.017) | 0.042 (0.002) |
| | | 10 | 0.275 (0.054) | 0.105 (0.004) | 0.323 (0.053) | 0.050 (0.005) |
| | | 20 | 0.237 (0.132) | 0.118 (0.006) | 0.506 (0.077) | 0.074 (0.012) |
| summer | offshore | 1 | 0.150 (0.018) | 0.103 (0.005) | 0.232 (0.033) | 0.059 (0.004) |
| | | 5 | 0.171 (0.030) | 0.089 (0.000) | 0.197 (0.025) | 0.054 (0.004) |
| | | 10 | 0.173 (0.008) | 0.102 (0.010) | 0.184 (0.015) | 0.055 (0.002) |
| | | 20 | 0.269 (0.029) | 0.097 (0.014) | 0.312 (0.101) | 0.053 (0.005) |
| winter | nearshore | 1 | 0.518 (0.052) | 0.208 (0.062) | 0.554 (0.028) | 0.082 (0.006) |
| | | 5 | 0.507 (0.040) | 0.237 (0.066) | 0.609 (0.021) | 0.092 (0.012) |
| | | 10 | 0.496 (0.072) | 0.248 (0.069) | 0.642 (0.109) | 0.084 (0.005) |
| | | 20 | 0.547 (0.089) | 0.303 (0.046) | 0.692 (0.184) | 0.083 (0.005) |
| winter | midshore | 1 | 0.428 (0.098) | 0.157 (0.015) | 0.583 (0.033) | 0.092 (0.003) |
| | | 5 | 0.429 (0.119) | 0.144 (0.024) | 0.529 (0.043) | 0.086 (0.003) |
| | | 10 | 0.451 (0.092) | 0.143 (0.019) | 0.506 (0.026) | 0.087 (0.004) |
| | | 20 | 0.467 (0.089) | 0.146 (0.027) | 0.512 (0.014) | 0.089 (0.007) |
| winter | offshore | 1 | 0.253 (0.032) | 0.124 (0.013) | 0.544 (0.066) | 0.099 (0.013) |
| | | 5 | 0.250 (0.032) | 0.099 (0.002) | 0.576 (0.066) | 0.086 (0.003) |
| | | 10 | 0.282 (0.047) | 0.095 (0.002) | 0.557 (0.052) | 0.093 (0.002) |
| | | 20 | 0.313 (0.030) | 0.096 (0.002) | 0.528 (0.046) | 0.088 (0.004) |

Table S1 cont.

| season | site | depth (m) | nitrite + nitrate ($\mu\text{mol l}^{-1}$) | ammonia ($\mu\text{mol l}^{-1}$) | $\delta^{13}\text{C}$ | $\delta^{15}\text{N}$ |
|--------|-----------|--------------|---|---------------------------------------|-----------------------|-----------------------|
| summer | nearshore | 1 | 0.237 (0.076) | 0.282 (0.091) | -18.76 (0.61) | 3.373 (0.453) |
| | | 5 | 0.169 (0.064) | 0.194 (0.122) | -19.22 (0.68) | 2.650 (0.053) |
| | | 10 | 0.129 (0.021) | 0.045 (0.020) | -20.60 (0.45) | 2.310 (0.183) |
| | | 20 | 0.118 (0.022) | 0.262 (0.046) | -20.07 (0.43) | 3.179 (0.246) |
| | midshore | 1 | 0.224 (0.092) | 0.222 (0.029) | -21.66 (0.70) | 3.386 (0.133) |
| | | 5 | 0.134 (0.033) | 0.173 (0.050) | -21.42 (0.51) | 2.127 (0.275) |
| | | 10 | 0.050 (0.029) | 0.198 (0.070) | -21.43 (0.44) | 1.966 (0.190) |
| | | 20 | 0.075 (0.025) | 0.079 (0.018) | -21.75 (0.12) | 2.623 (0.237) |
| | offshore | 1 | 0.267 (0.150) | 0.213 (0.077) | -21.65 (0.80) | 1.832 (0.127) |
| | | 5 | 0.199 (0.097) | 0.159 (0.037) | -21.58 (0.26) | 2.227 (0.666) |
| | | 10 | 0.220 (0.073) | 0.236 (0.070) | -20.92 (0.69) | 1.652 (0.268) |
| | | 20 | 0.145 (0.033) | 0.048 (0.031) | -21.46 (0.37) | 3.433 (0.887) |
| winter | nearshore | 1 | 0.142 (0.013) | 0.212 (0.017) | -23.31 (0.39) | 2.916 (0.345) |
| | | 5 | 0.126 (0.016) | 0.229 (0.081) | -23.15 (0.15) | 2.730 (0.349) |
| | | 10 | 0.142 (0.021) | 0.096 (0.043) | -23.46 (0.44) | 2.548 (0.317) |
| | | 20 | 0.134 (0.034) | 0.224 (0.080) | -23.27 (0.44) | 3.116 (0.490) |
| | midshore | 1 | 0.218 (0.013) | 0.171 (0.053) | -23.76 (0.23) | 3.081 (0.480) |
| | | 5 | 0.187 (0.008) | 0.211 (0.058) | -23.93 (0.37) | 3.386 (0.702) |
| | | 10 | 0.192 (0.029) | 0.127 (0.021) | -23.99 (0.20) | 2.674 (0.622) |
| | | 20 | 0.211 (0.035) | 0.174 (0.037) | -24.02 (0.32) | 2.414 (0.218) |
| | offshore | 1 | 0.145 (0.054) | 0.127 (0.033) | -24.10 (0.42) | 2.350 (0.828) |
| | | 5 | 0.166 (0.068) | 0.115 (0.054) | -24.09 (0.43) | 2.330 (0.089) |
| | | 10 | 0.166 (0.026) | 0.193 (0.079) | -24.04 (0.78) | 2.455 (1.173) |
| | | 20 | 0.154 (0.013) | 0.107 (0.043) | -24.24 (0.31) | 2.751 (0.064) |

Table S1 cont.

| season | site | depth (m) | %o C | %o N | C : N | total suspended matter (mg l ⁻¹) |
|--------|-----------|--------------|--------------|--------------|---------------|---|
| summer | nearshore | 1 | 155.2 (10.8) | 21.77 (2.67) | 7.239 (0.565) | 2.410 (0.028) |
| | | 5 | 141.2 (7.44) | 21.73 (2.74) | 6.636 (0.623) | 2.676 (0.432) |
| | | 10 | 141.3 (1.60) | 23.20 (0.39) | 6.091 (0.067) | 2.693 (0.604) |
| | | 20 | 206.0 (24.7) | 35.23 (4.38) | 5.858 (0.127) | 1.915 (0.443) |
| summer | midshore | 1 | 135.8 (3.64) | 20.93 (1.07) | 6.506 (0.184) | 2.034 (0.740) |
| | | 5 | 135.9 (9.52) | 21.15 (1.94) | 6.447 (0.129) | 2.756 (0.429) |
| | | 10 | 126.4 (9.84) | 20.14 (1.34) | 6.272 (0.124) | 2.267 (0.754) |
| | | 20 | 140.9 (15.2) | 22.56 (3.58) | 6.369 (0.385) | 2.522 (0.030) |
| summer | offshore | 1 | 94.93 (11.5) | 12.65 (1.85) | 7.561 (0.273) | 2.023 (0.640) |
| | | 5 | 97.17 (8.73) | 13.61 (1.85) | 7.226 (0.335) | 1.827 (0.293) |
| | | 10 | 103.1 (9.97) | 14.33 (2.02) | 7.313 (0.507) | 2.291 (0.313) |
| | | 20 | 116.5 (11.8) | 16.93 (3.24) | 7.139 (0.677) | 2.518 (0.557) |
| winter | nearshore | 1 | 130.9 (12.4) | 20.62 (2.46) | 6.382 (0.184) | 2.561 (0.108) |
| | | 5 | 136.1 (4.50) | 21.32 (1.46) | 6.418 (0.264) | 2.647 (0.667) |
| | | 10 | 137.9 (10.3) | 19.77 (2.64) | 7.120 (0.609) | 3.441 (0.567) |
| | | 20 | 135.6 (3.95) | 21.82 (1.53) | 6.251 (0.264) | 2.180 (0.461) |
| winter | midshore | 1 | 125.0 (21.6) | 19.28 (3.63) | 6.547 (0.211) | 2.897 (0.483) |
| | | 5 | 136.7 (25.0) | 20.49 (4.52) | 6.822 (0.379) | 2.368 (0.247) |
| | | 10 | 128.3 (19.8) | 19.53 (3.22) | 6.598 (0.119) | 2.436 (0.351) |
| | | 20 | 124.5 (20.4) | 18.22 (3.62) | 6.962 (0.332) | 2.388 (0.257) |
| winter | offshore | 1 | 102.6 (15.6) | 15.84 (3.73) | 6.810 (0.757) | 2.314 (0.340) |
| | | 5 | 100.4 (3.82) | 15.27 (1.81) | 6.715 (0.577) | 2.543 (0.380) |
| | | 10 | 120.1 (34.3) | 20.66 (9.50) | 6.734 (1.061) | 2.656 (0.515) |
| | | 20 | 104.2 (4.48) | 14.90 (0.62) | 6.997 (0.193) | 2.261 (0.493) |

Table S2. Data of physiological variables measured in the coral *Pocillopora verrucosa*.
 Measurements were taken from coral colonies in the central Red Sea over sampling times (winter/ summer), sites (nearshore, midshore, offshore) and water depth (1, 5, 10, 20 m). Data given as means (standard errors in parentheses), chl = chlorophyll, ETR_{max} = maximum electron transport rate, E_k = minimum saturating irradiance, α = light use coefficient, ΔF/Fm' = effective quantum yield.

| season | site | depth (m) | <i>Symbiodinium</i> cells (*10 ⁶ cm ⁻²) | chl α (fmol symbiont ⁻¹) | chl c_2 chl α^{-1} | peridinin chl α^{-1} |
|--------|-----------|--------------|---|--|-----------------------------|-----------------------------|
| summer | nearshore | 1 | 2.074 (0.878) | 5.137 (1.209) | 0.124 (0.116) | 0.871 (0.214) |
| | | 5 | 0.993 (0.132) | 5.499 (0.471) | 0.236 (0.031) | 0.699 (0.005) |
| | | 10 | 1.629 (0.132) | 5.294 (0.395) | 0.153 (0.053) | 0.780 (0.029) |
| | | 20 | 1.836 (0.293) | 7.067 (0.142) | 0.239 (0.085) | 0.801 (0.036) |
| summer | midshore | 1 | 1.600 (0.079) | 5.008 (0.669) | 0.265 (0.056) | 1.063 (0.135) |
| | | 5 | 1.568 (0.244) | 6.658 (0.694) | 0.214 (0.069) | 0.897 (0.046) |
| | | 10 | 1.380 (0.224) | 5.947 (0.395) | 0.277 (0.044) | 0.821 (0.057) |
| | | 20 | 0.931 (0.083) | 7.021 (0.484) | 0.276 (0.058) | 0.793 (0.032) |
| summer | offshore | 1 | 1.670 (0.057) | 3.901 (0.853) | 0.132 (0.062) | 1.433 (0.554) |
| | | 5 | 1.348 (0.358) | 5.815 (0.477) | 0.242 (0.076) | 0.859 (0.048) |
| | | 10 | 1.848 (0.273) | 5.687 (0.618) | 0.110 (0.061) | 0.718 (0.022) |
| | | 20 | 1.030 (0.185) | 6.850 (1.080) | 0.212 (0.081) | 0.797 (0.019) |
| winter | nearshore | 1 | | | | |
| | | 5 | | | | |
| | | 10 | 1.208 (0.182) | 6.174 (0.700) | 0.072 (0.019) | 0.778 (0.027) |
| | | 20 | 1.146 (0.242) | 7.281 (0.695) | 0.061 (0.014) | 0.793 (0.031) |
| winter | midshore | 1 | 1.418 (0.129) | 4.030 (0.579) | 0.109 (0.032) | 1.113 (0.213) |
| | | 5 | 1.623 (0.148) | 5.001 (0.607) | 0.061 (0.021) | 1.299 (0.155) |
| | | 10 | 1.679 (0.245) | 6.668 (1.338) | 0.027 (0.004) | 0.997 (0.108) |
| | | 20 | 1.194 (0.094) | 6.878 (1.398) | 0.055 (0.020) | 1.026 (0.229) |
| winter | offshore | 1 | 1.330 (0.046) | 2.388 (0.287) | 0.143 (0.041) | 2.418 (0.409) |
| | | 5 | 1.117 (0.119) | 3.888 (0.385) | 0.095 (0.026) | 1.779 (0.241) |
| | | 10 | 1.009 (0.155) | 6.011 (1.339) | 0.069 (0.016) | 1.100 (0.178) |
| | | 20 | 0.801 (0.146) | 8.453 (1.136) | 0.093 (0.021) | 0.826 (0.055) |

Table S2 cont.

| season | site | depth (m) | β -carotene chl a^{-1} | diadinoxanthin chl a^{-1} | diatoxanthin chl a^{-1} | xanthophyll de-epoxidation |
|--------|-----------|--------------|--------------------------------|--------------------------------|------------------------------|-------------------------------|
| summer | nearshore | 1 | 0.015 (0.007) | 0.385 (0.064) | 0.084 (0.042) | 0.168 (0.051) |
| | | 5 | 0.021 (0.005) | 0.396 (0.023) | 0.048 (0.009) | 0.107 (0.018) |
| | | 10 | 0.020 (0.002) | 0.371 (0.014) | 0.046 (0.005) | 0.112 (0.015) |
| | | 20 | 0.023 (0.002) | 0.337 (0.012) | 0.034 (0.001) | 0.093 (0.004) |
| | midshore | 1 | 0.005 (0.001) | 0.539 (0.078) | 0.079 (0.017) | 0.129 (0.027) |
| | | 5 | 0.005 (0.001) | 0.449 (0.028) | 0.034 (0.002) | 0.072 (0.005) |
| | | 10 | 0.011 (0.002) | 0.418 (0.027) | 0.039 (0.006) | 0.085 (0.008) |
| | | 20 | 0.026 (0.002) | 0.372 (0.011) | 0.036 (0.001) | 0.088 (0.001) |
| | offshore | 1 | 0.008 (0.002) | 0.714 (0.295) | 0.108 (0.027) | 0.149 (0.030) |
| | | 5 | 0.007 (0.001) | 0.430 (0.019) | 0.041 (0.003) | 0.087 (0.006) |
| | | 10 | 0.019 (0.007) | 0.368 (0.01) | 0.033 (0.004) | 0.081 (0.008) |
| | | 20 | 0.027 (0.001) | 0.356 (0.011) | 0.033 (0.003) | 0.087 (0.009) |
| winter | nearshore | 1 | | | | |
| | | 5 | | | | |
| | | 10 | 0.013 (0.002) | 0.347 (0.011) | 0.039 (0.001) | 0.102 (0.001) |
| | | 20 | 0.017 (0.002) | 0.342 (0.013) | 0.032 (0.005) | 0.085 (0.010) |
| | midshore | 1 | 0.040 (0.034) | 0.532 (0.094) | 0.095 (0.028) | 0.142 (0.020) |
| | | 5 | 0.005 (0.001) | 0.614 (0.076) | 0.110 (0.018) | 0.153 (0.014) |
| | | 10 | 0.010 (0.002) | 0.437 (0.047) | 0.053 (0.005) | 0.110 (0.003) |
| | | 20 | 0.015 (0.002) | 0.436 (0.105) | 0.047 (0.016) | 0.092 (0.011) |
| | offshore | 1 | 0.008 (0.001) | 1.187 (0.196) | 0.203 (0.044) | 0.144 (0.010) |
| | | 5 | 0.006 (0.001) | 0.815 (0.099) | 0.111 (0.020) | 0.117 (0.011) |
| | | 10 | 0.013 (0.002) | 0.453 (0.084) | 0.050 (0.007) | 0.100 (0.002) |
| | | 20 | 0.014 (0.001) | 0.344 (0.026) | 0.027 (0.003) | 0.072 (0.005) |

Table S2 cont.

| season | site | depth (m) | ETR _{max} (μmol electrons m ⁻² s ⁻¹) | E _K (μmol photons m ⁻² s ⁻¹) | α | ΔF/Fm' | protein (mg cm ⁻²) |
|-----------|----------|--------------|--|--|---------------|---------------|-----------------------------------|
| nearshore | | 1 | 146.9 (6.2) | 644.6 (15.7) | 0.228 (0.015) | 0.506 (0.045) | 1.433 (0.431) |
| | | 5 | 128.2 (7.8) | 584.9 (65.4) | 0.222 (0.012) | 0.541 (0.041) | 0.842 (0.121) |
| | | 10 | 170.4 (9.5) | 660.5 (37.5) | 0.258 (0.001) | 0.589 (0.016) | 0.906 (0.075) |
| | | 20 | 123.9 (10.8) | 472.9 (35.8) | 0.261 (0.003) | 0.636 (0.005) | 0.947 (0.118) |
| summer | midshore | 1 | 160.6 (12.7) | 735.4 (66.1) | 0.219 (0.008) | 0.468 (0.015) | 1.402 (0.146) |
| | | 5 | 132.1 (1.9) | 540.8 (9.0) | 0.244 (0.001) | 0.592 (0.007) | 1.063 (0.075) |
| | | 10 | 146.6 (8.4) | 559.4 (27.8) | 0.261 (0.002) | 0.580 (0.010) | 0.843 (0.098) |
| | | 20 | 126.8 (14.7) | 492.6 (50.1) | 0.256 (0.004) | 0.596 (0.010) | 0.687 (0.059) |
| offshore | | 1 | 173.1 (8.4) | 888.0 (27.7) | 0.194 (0.003) | 0.453 (0.016) | 1.353 (0.050) |
| | | 5 | 136.1 (8.5) | 604.1 (40.8) | 0.225 (0.001) | 0.578 (0.008) | 0.937 (0.191) |
| | | 10 | 168.6 (7.6) | 695.1 (36.7) | 0.242 (0.003) | 0.563 (0.006) | 1.036 (0.058) |
| | | 20 | 141.6 (7.8) | 565.5 (31.6) | 0.250 (0.001) | 0.613 (0.004) | 0.761 (0.027) |
| nearshore | | 1 | | | | | |
| | | 5 | | | | | |
| | | 10 | 101.6 (7.2) | 418.1 (24.7) | 0.242 (0.003) | 0.628 (0.007) | 1.016 (0.104) |
| | | 20 | 96.3 (10.0) | 418.0 (34.2) | 0.229 (0.007) | 0.647 (0.003) | 0.871 (0.177) |
| winter | midshore | 1 | 131.8 (7.5) | 640.7 (37.7) | 0.206 (0.009) | 0.525 (0.031) | 1.325 (0.118) |
| | | 5 | 108.5 (10.1) | 458.1 (40.2) | 0.236 (0.001) | 0.597 (0.026) | 1.476 (0.060) |
| | | 10 | 112.1 (2.3) | 443.7 (9.8) | 0.252 (0.002) | 0.658 (0.008) | 1.303 (0.180) |
| | | 20 | 95.5 (11.2) | 407.5 (39.4) | 0.233 (0.004) | 0.663 (0.007) | 0.901 (0.024) |
| offshore | | 1 | 128.2 (3.8) | 566.9 (22.1) | 0.226 (0.003) | 0.539 (0.003) | 1.282 (0.130) |
| | | 5 | 117.5 (4.8) | 521.0 (19.0) | 0.225 (0.002) | 0.604 (0.012) | 1.175 (0.130) |
| | | 10 | 135.0 (8.1) | 557.6 (27.8) | 0.241 (0.004) | 0.613 (0.012) | 0.990 (0.030) |
| | | 20 | 104.8 (1.5) | 451.5 (4.5) | 0.232 (0.003) | 0.637 (0.009) | 0.542 (0.039) |

Table S3. Data of physiological variables measured in the coral *Porites lutea*.
 Measurements were taken from coral colonies in the central Red Sea over sampling times (winter/ summer), sites (nearshore, midshore, offshore) and water depth (1, 5, 10, 20 m). Data given as means (standard errors in parentheses), chl = chlorophyll, ETR_{max} = maximum electron transport rate, E_k = minimum saturating irradiance, α = light use coefficient, $\Delta F/Fm'$ = effective quantum yield.

| season | site | depth (m) | <i>Symbiodinium</i> cells (*10 ⁶ cm ⁻²) | chl a (fmol symbiont ⁻¹) | chl c ₂ chl a ⁻¹ | peridinin chl a ⁻¹ |
|--------|-----------|--------------|---|---|--|-------------------------------|
| summer | nearshore | 1 | 1.878 (0.264) | 3.750 (0.535) | 0.170 (0.060) | 0.876 (0.053) |
| | | 5 | 1.507 (0.271) | 3.704 (0.659) | 0.231 (0.052) | 1.031 (0.088) |
| | | 10 | 1.659 (0.14) | 4.296 (0.734) | 0.174 (0.055) | 0.960 (0.052) |
| | | 20 | 2.413 (0.401) | 5.970 (0.601) | 0.211 (0.088) | 1.047 (0.048) |
| | midshore | 1 | 2.800 (0.627) | 4.048 (0.242) | 0.266 (0.034) | 0.907 (0.027) |
| | | 5 | 2.995 (0.596) | 3.459 (0.313) | 0.180 (0.065) | 0.983 (0.134) |
| | | 10 | 2.700 (0.408) | 5.455 (0.698) | 0.250 (0.087) | 0.968 (0.034) |
| | | 20 | 0.830 (0.206) | 5.875 (0.188) | 0.304 (0.029) | 0.983 (0.022) |
| winter | offshore | 1 | 1.712 (0.339) | 5.017 (1.037) | 0.158 (0.052) | 0.903 (0.018) |
| | | 5 | 1.158 (0.101) | 3.978 (0.306) | 0.245 (0.085) | 0.843 (0.024) |
| | | 10 | 2.142 (0.380) | 3.837 (0.112) | 0.163 (0.009) | 0.817 (0.021) |
| | | 20 | 0.917 (0.298) | 5.469 (0.374) | 0.154 (0.091) | 0.872 (0.030) |
| | nearshore | 1 | 1.715 (0.346) | 3.078 (0.126) | 0.165 (0.009) | 0.950 (0.028) |
| | | 5 | 0.971 (0.242) | 2.381 (0.624) | 0.131 (0.041) | 2.620 (1.583) |
| | | 10 | 0.889 (0.120) | 5.309 (0.457) | 0.143 (0.038) | 0.933 (0.041) |
| | | 20 | 1.940 (0.129) | 5.103 (0.804) | 0.188 (0.124) | 1.329 (0.331) |
| | midshore | 1 | 2.070 (0.389) | 2.523 (0.626) | 0.204 (0.083) | 1.616 (0.427) |
| | | 5 | 1.658 (0.158) | 4.032 (0.744) | 0.178 (0.082) | 1.135 (0.109) |
| | | 10 | 2.570 (0.673) | 5.496 (0.484) | 0.053 (0.028) | 0.903 (0.054) |
| | | 20 | 1.397 (0.386) | 5.631 (1.209) | 0.111 (0.048) | 1.026 (0.179) |
| | offshore | 1 | 1.620 (0.154) | 4.387 (0.207) | 0.035 (0.002) | 0.942 (0.043) |
| | | 5 | 3.112 (0.574) | 3.246 (0.598) | 0.074 (0.019) | 1.312 (0.122) |
| | | 10 | 1.113 (0.203) | 3.633 (0.840) | 0.079 (0.011) | 1.415 (0.453) |
| | | 20 | 0.544 (0.143) | 5.842 (0.676) | 0.081 (0.013) | 1.038 (0.053) |

Table S3 cont.

| season | site | depth (m) | β -carotene chl a^{-1} | diadinoxanthin chl a^{-1} | diatoxanthin chl a^{-1} | xanthophyll de- epoxidation |
|--------|-----------|--------------|--------------------------------|--------------------------------|------------------------------|--------------------------------|
| summer | nearshore | 1 | 0.026 (0.004) | 0.509 (0.062) | 0.095 (0.031) | 0.145 (0.028) |
| | | 5 | 0.031 (0.010) | 0.494 (0.033) | 0.055 (0.015) | 0.102 (0.029) |
| | | 10 | 0.021 (0.007) | 0.495 (0.032) | 0.040 (0.003) | 0.075 (0.003) |
| | | 20 | 0.020 (0.003) | 0.380 (0.015) | 0.024 (0.003) | 0.060 (0.006) |
| summer | midshore | 1 | 0.022 (0.004) | 0.485 (0.018) | 0.047 (0.002) | 0.089 (0.007) |
| | | 5 | 0.015 (0.005) | 0.547 (0.020) | 0.030 (0.004) | 0.052 (0.008) |
| | | 10 | 0.027 (0.007) | 0.440 (0.010) | 0.045 (0.009) | 0.093 (0.018) |
| | | 20 | 0.025 (0.006) | 0.419 (0.018) | 0.045 (0.001) | 0.098 (0.005) |
| summer | offshore | 1 | 0.018 (0.003) | 0.531 (0.038) | 0.053 (0.013) | 0.089 (0.014) |
| | | 5 | 0.025 (0.003) | 0.561 (0.032) | 0.041 (0.005) | 0.068 (0.006) |
| | | 10 | 0.029 (0.004) | 0.489 (0.022) | 0.047 (0.005) | 0.088 (0.008) |
| | | 20 | 0.029 (0.002) | 0.425 (0.022) | 0.041 (0.003) | 0.089 (0.011) |
| winter | nearshore | 1 | 0.015 (0.003) | 0.517 (0.039) | 0.080 (0.019) | 0.133 (0.032) |
| | | 5 | 0.017 (0.001) | 1.079 (0.593) | 0.104 (0.049) | 0.096 (0.006) |
| | | 10 | 0.020 (0.003) | 0.388 (0.039) | 0.033 (0.003) | 0.081 (0.007) |
| | | 20 | 0.009 (0.001) | 0.476 (0.104) | 0.032 (0.008) | 0.063 (0.005) |
| winter | midshore | 1 | 0.009 (0.001) | 0.842 (0.148) | 0.188 (0.057) | 0.167 (0.020) |
| | | 5 | 0.010 (0.002) | 0.646 (0.070) | 0.059 (0.009) | 0.084 (0.009) |
| | | 10 | 0.014 (0.002) | 0.454 (0.007) | 0.038 (0.003) | 0.077 (0.005) |
| | | 20 | 0.016 (0.003) | 0.475 (0.094) | 0.042 (0.007) | 0.083 (0.005) |
| winter | offshore | 1 | 0.010 (0.002) | 0.503 (0.037) | 0.076 (0.011) | 0.131 (0.019) |
| | | 5 | 0.008 (0.002) | 0.592 (0.067) | 0.084 (0.009) | 0.125 (0.005) |
| | | 10 | 0.018 (0.004) | 0.673 (0.231) | 0.045 (0.013) | 0.064 (0.006) |
| | | 20 | 0.015 (0.002) | 0.433 (0.02) | 0.060 (0.008) | 0.123 (0.019) |

Table S3 cont.

| season | site | depth (m) | ETR_{\max} ($\mu\text{mol electrons m}^{-2} \text{s}^{-1}$) | E_K ($\mu\text{mol photons m}^{-2} \text{s}^{-1}$) | α | $\Delta F/F_m'$ | protein (mg cm^{-2}) |
|-----------|----------|--------------|---|---|---------------|-----------------|------------------------------------|
| nearshore | | 1 | 64.04 (4.54) | 340.9 (19.4) | 0.187 (0.006) | 0.355 (0.010) | 1.138 (0.24) |
| | | 5 | 52.00 (3.43) | 245.2 (19.5) | 0.214 (0.013) | 0.413 (0.018) | 0.939 (0.081) |
| | | 10 | 52.87 (7.25) | 228.5 (21.6) | 0.228 (0.014) | 0.503 (0.016) | 0.931 (0.109) |
| | | 20 | 33.64 (1.74) | 178.2 (9.7) | 0.189 (0.006) | 0.639 (0.013) | 1.240 (0.138) |
| summer | midshore | 1 | 55.83 (2.47) | 344.9 (32.1) | 0.163 (0.007) | 0.418 (0.012) | 1.182 (0.247) |
| | | 5 | 54.23 (4.87) | 258.0 (16.3) | 0.209 (0.007) | 0.491 (0.013) | 1.317 (0.288) |
| | | 10 | 49.93 (4.41) | 250.0 (24.9) | 0.200 (0.002) | 0.478 (0.014) | 1.993 (0.199) |
| | | 20 | 36.71 (3.07) | 178.1 (6.7) | 0.205 (0.012) | 0.590 (0.014) | 0.904 (0.076) |
| offshore | | 1 | 58.33 (1.91) | 341.0 (29.6) | 0.173 (0.010) | 0.379 (0.014) | 1.134 (0.097) |
| | | 5 | 58.60 (6.43) | 254.3 (21.1) | 0.229 (0.010) | 0.441 (0.020) | 0.725 (0.073) |
| | | 10 | 50.08 (4.05) | 263.0 (5.6) | 0.190 (0.013) | 0.406 (0.021) | 1.406 (0.229) |
| | | 20 | 45.93 (1.77) | 197.9 (5.6) | 0.231 (0.004) | 0.542 (0.015) | 0.982 (0.301) |
| nearshore | | 1 | 101.20 (3.25) | 609.1 (29.0) | 0.167 (0.010) | 0.394 (0.016) | 1.306 (0.158) |
| | | 5 | 66.93 (5.66) | 312.8 (28.4) | 0.214 (0.005) | 0.541 (0.015) | 0.526 (0.035) |
| | | 10 | 60.35 (5.23) | 281.5 (17.1) | 0.213 (0.005) | 0.590 (0.011) | 0.797 (0.121) |
| | | 20 | 44.44 (1.76) | 234.8 (8.5) | 0.189 (0.004) | 0.679 (0.021) | 1.007 (0.064) |
| winter | midshore | 1 | 75.45 (4.03) | 528.1 (81.8) | 0.155 (0.020) | 0.342 (0.014) | 1.985 (0.209) |
| | | 5 | 69.57 (4.19) | 335.3 (15.9) | 0.207 (0.007) | 0.453 (0.006) | 1.264 (0.159) |
| | | 10 | 71.80 (4.11) | 319.1 (21.3) | 0.225 (0.002) | 0.583 (0.013) | 1.552 (0.240) |
| | | 20 | 45.83 (0.64) | 229.4 (4.4) | 0.199 (0.003) | 0.637 (0.022) | 0.994 (0.141) |
| offshore | | 1 | 79.37 (5.94) | 513.0 (46.6) | 0.155 (0.002) | 0.439 (0.017) | 1.534 (0.227) |
| | | 5 | 83.62 (3.98) | 389.1 (21.0) | 0.215 (0.006) | 0.525 (0.023) | 2.389 (0.176) |
| | | 10 | 59.61 (2.19) | 292.1 (10.3) | 0.204 (0.001) | 0.599 (0.009) | 0.629 (0.164) |
| | | 20 | 55.66 (1.21) | 259.6 (5.1) | 0.214 (0.003) | 0.596 (0.012) | 0.616 (0.220) |

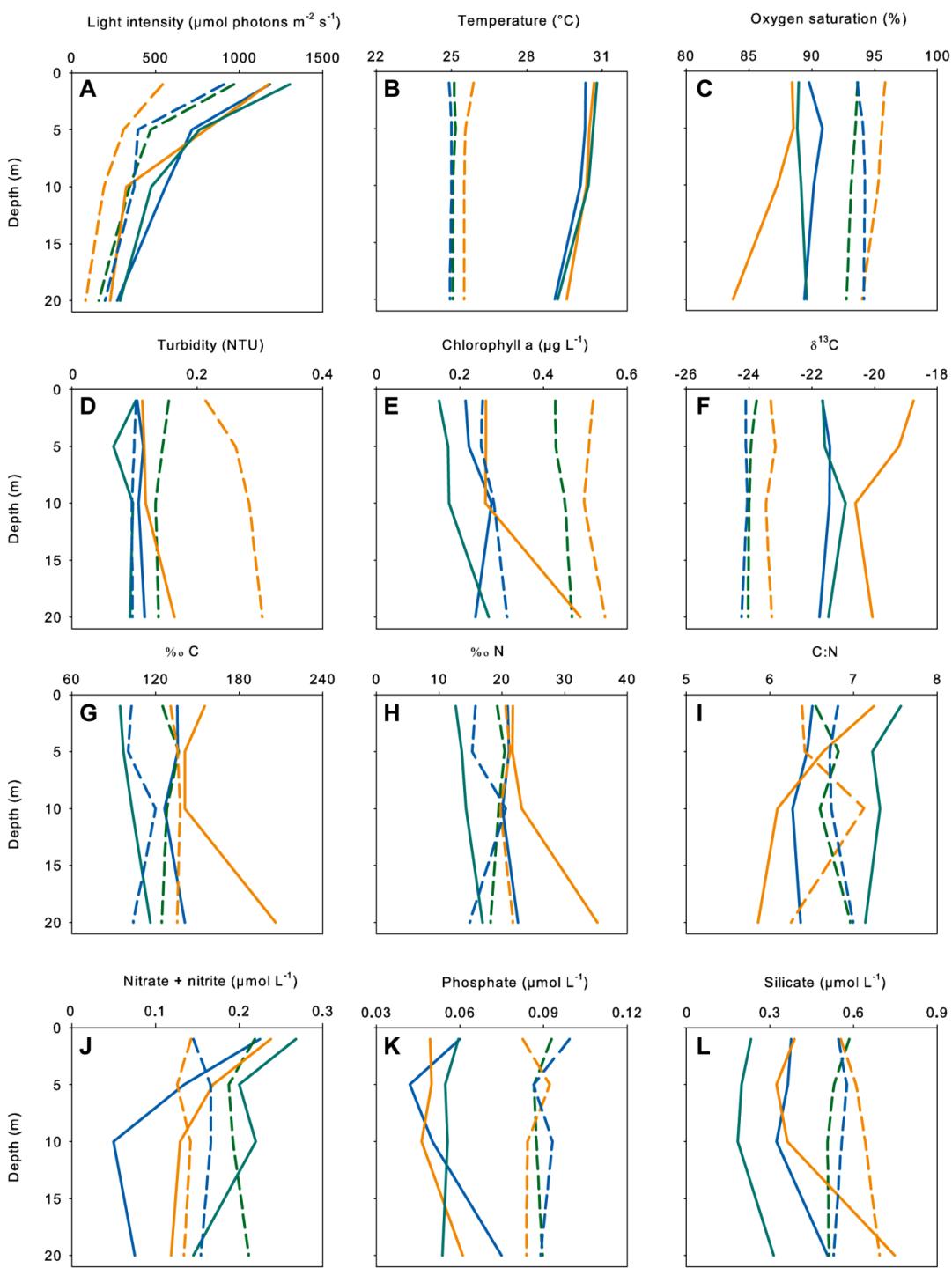


Figure S1. Profiles of environmental variables (means) measured during summer and winter in the central Red Sea. (A) light intensity, (B) temperature, (C) oxygen saturation, (D) turbidity, (E) chlorophyll *a*, (F) $\delta^{13}\text{C}$, (G) %C, (H) %N, (I) C:N, (J) nitrate + nitrite, (K) phosphate, (L) silicate. Dashed lines = winter, solid lines = summer, line colors represent cross-shelf locations: orange = nearshore, green = midshore, blue = offshore.

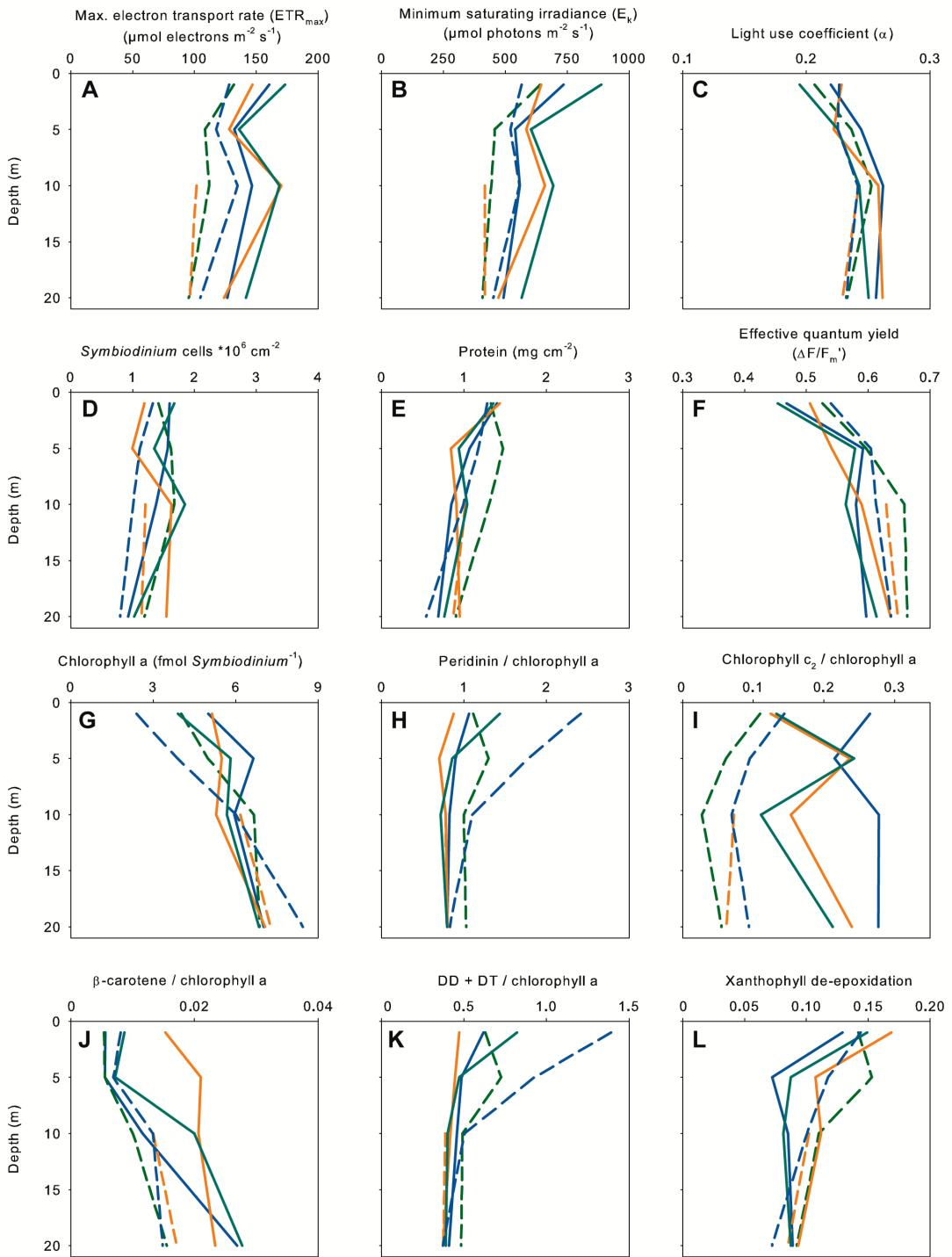


Figure S2. Profiles of physiological variables (means) measured during winter and summer in the coral *Pocillopora verrucosa* in the central Red Sea. (A) maximum electron transport rate, (B) minimum saturating irradiance, (C) light use coefficient, (D) *Symbiodinium* cell density, (E) total protein, (F) effective quantum yield, (G) chlorophyll (chl) a Symbiodinium^{-1} , (H) peridinin chl a $^{-1}$, (I) chl c_2 chl a $^{-1}$, (J) β -carotene chl a $^{-1}$, (K) diadinoxanthin and diatoxanthin chl a $^{-1}$, (L) xanthophyll de-epoxidation. Photosynthetic pigments (H-L) displayed as molar ratios. Dashed lines = winter, solid lines = summer, line colors represent cross-shelf locations: orange = nearshore, green = midshore, blue = offshore.

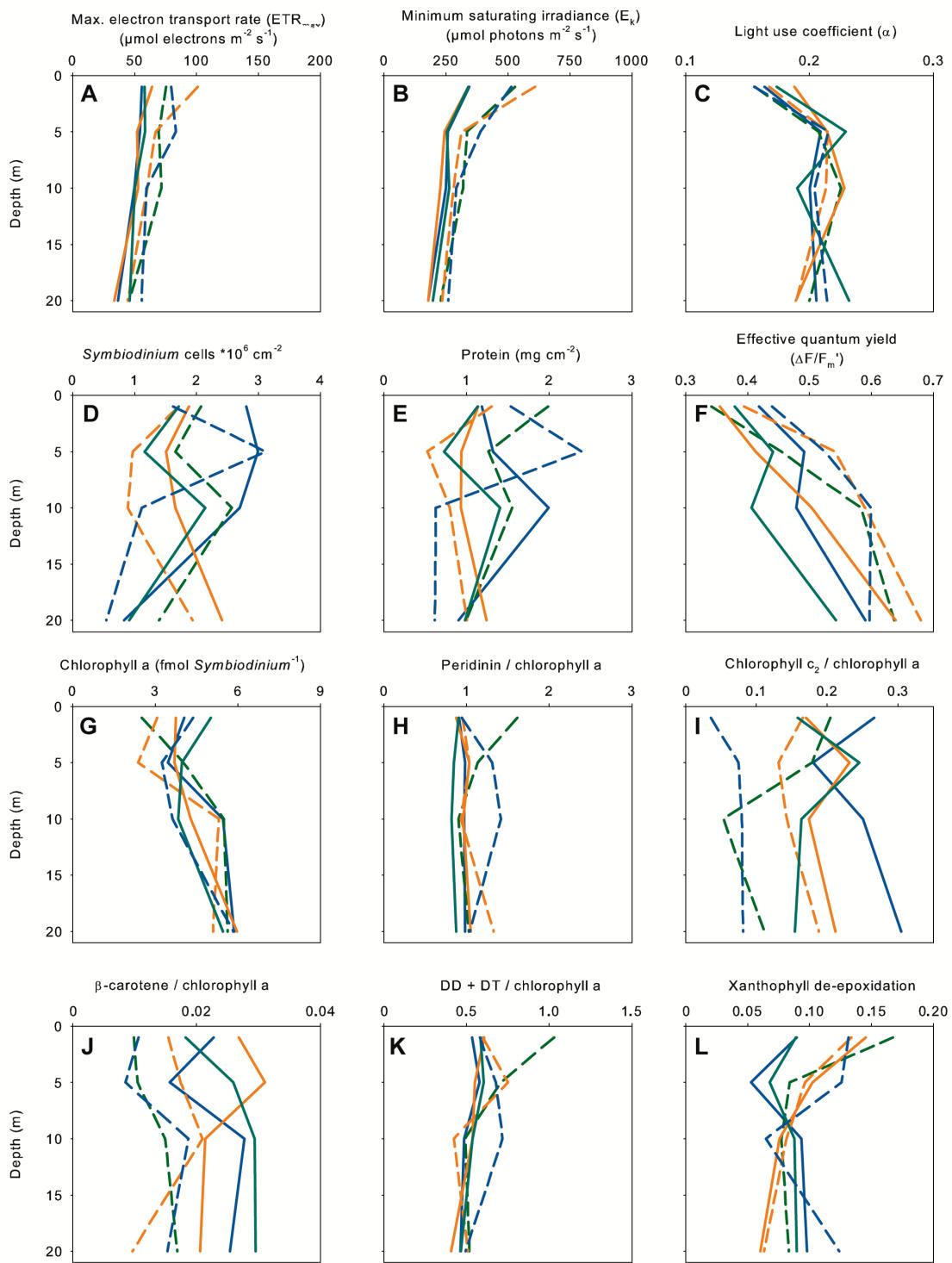


Figure S3. Profiles of physiological variables (means) measured during winter and summer in the coral *Porites lutea* in the central Red Sea. (A) maximum electron transport rate, (B) minimum saturating irradiance, (C) light use coefficient, (D) *Symbiodinium* cell density, (E) total protein, (F) effective quantum yield, (G) chlorophyll (chl) a Symbiodinium^{-1} , (H) peridinin chl a⁻¹, (I) chl c_2 chl a⁻¹, (J) β -carotene chl a⁻¹, (K) diadinoxanthin and diatoxanthin chl a⁻¹, (L) xanthophyll de-epoxidation. Photosynthetic pigments (H-L) displayed as molar ratios. Dashed lines = winter, solid lines = summer, line colors represent cross-shelf locations: orange = nearshore, green = midshore, blue = offshore.

Supplemental results

Detailed results of abiotic variables:

Water temperature, light intensity, and, to a lesser degree, salinity were all significantly higher in summer than in winter (Table 1, Fig. 3A). In contrast, several factors indicating increases in ecosystem productivity related to nutrient enrichment were increased in winter; these include turbidity, chlorophyll, oxygen saturation, silicate, and phosphate, while $\delta^{13}\text{C}$ decreased during winter (Table 1, Fig. S1, Table S1).

Temperature, turbidity, and $\delta^{13}\text{C}$ significantly decreased with distance to shore (pairwise PERMANOVA, $p < 0.05$, $p < 0.05$, and $p < 0.01$, respectively). For most environmental parameters, there was an interaction between the factors season and site: For instance, light levels were similar across sites during summer, while in winter, they were significantly lower nearshore compared to midshore and offshore (pairwise PERMANOVA, both $p < 0.005$). Probably, increased chlorophyll concentrations in the water column with proximity to the coast caused the observed pattern. In winter, chlorophyll concentrations in the water column were significantly decreased offshore compared to midshore ($p < 0.005$) and nearshore ($p < 0.001$) and in summer site differences were smaller but still significant between nearshore and offshore (pairwise PERMANOVA, $p < 0.05$).

Salinity, silicate concentrations, and C:N ratios were comparable between sites during winter and showed a cross-shelf pattern during summer. In summer, salinity at the midshore site was significantly decreased compared to offshore and nearshore (pairwise PERMANOVA, both $p < 0.005$) and silicate concentrations were significantly reduced at the offshore site compared to midshore and nearshore (pairwise PERMANOVA, both $p < 0.001$). C:N ratios were significantly increased offshore compared to midshore (pairwise PERMANOVA, $p < 0.001$) and nearshore ($p > 0.01$). Total carbon and nitrogen content decreased significantly with distance to shore in summer (pairwise PERMANOVA, all $p < 0.01$ and $p < 0.001$, respectively), and in winter cross-shelf differences were small, but still significant between nearshore and offshore (both $p < 0.05$) with no significant difference to midshore (both $p > 0.05$). Oxygen saturation followed a reversed trend between seasons. While in summer oxygen saturation significantly decreased with proximity to shore (pairwise PERMANOVA, all $p < 0.01$), it was significantly increased at the nearshore site in winter compared to midshore ($p < 0.05$).

Light intensity decreased exponentially with depth and was the most prominent variable changing across depth (Table 1, Fig. 3A). Furthermore, oxygen saturation, temperature and nitrate + nitrite concentration decreased, while silicate, and water chl concentration increased with water depth from 1 to 20 m, respectively (Table 1, Fig. S1, Table S1). Throughout the study, ammonia, total suspended matter and $\delta^{15}\text{N}$ were stable between sampling points and seasons (Table 1).