**The biophysical controls of macroalgal growth on subtropical reefs**

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**SUPPLEMENTARY MATERIAL**

**Table 1s**. Relative cover (%) of taxonomic and morpho-functional groups observed in treatments of herbivores exclusion in rocky reefs of Arraial do Cabo, RJ (Brazil).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Morpho-functional group** | **Taxon** | **Shallow** | | **Deep** | |
| **mean** | **s.e.** | **mean** | **s.e.** |
| **Invertebrates** | **Porifera** |  |  |  |  |
|  | *Monachora* sp. | 0.14 | 0.02 | 0.71 | 0.06 |
|  | *Aplysina* sp. | 0.02 | 0.02 | 0.09 | 0.02 |
|  | **Scleractinia** |  |  |  |  |
|  | *Mussismilia hispida* | 0.00 | 0.00 | 0.02 | 0.01 |
|  | *Porites astreoides* | 0.15 | 0.10 | 0.00 | 0.00 |
|  | *Siderastrea stellata* | 0.00 | 0.00 | 0.12 | 0.03 |
|  | **Zoanthidea** |  |  |  |  |
|  | *Epizoanthus* sp*.* | 0.00 | 0.00 | 0.003 | 0.003 |
|  | *Zoanthus sociatus* | 0.00 | 0.00 | 0.003 | 0.003 |
|  | **Octocorallia** |  |  |  |  |
|  | *Carijoa riisei* | 0.00 | 0.00 | 0.003 | 0.003 |
|  | **Hydrozoa** |  |  |  |  |
|  | *Millepora alcicornis* | 1.35 | 0.35 | 0.00 | 0.00 |
|  | *Nemalecium lighti* | 0.03 | 0.02 | 0.00 | 0.00 |
|  | **Other** |  |  |  |  |
|  | *Bunodosoma caissarum* | 0.07 | 0.02 | 0.00 | 0.00 |
|  | *Clavelina oblonga* | 0.02 | 0.02 | 0.00 | 0.00 |
|  | *Botrylloides nigrum* | 0.12 | 0.08 | 0.02 | 0.01 |
|  | *Lissoclinum fragile* | 0.85 | 0.11 | 0.00 | 0.00 |
|  | Polychaete tube | 0.01 | 0.00 | 0.04 | 0.02 |
| **CCA** | **Crustose algae** |  |  |  |  |
|  | *Peyssonnelia* sp*.* | 1.50 | 0.13 | 0.15 | 0.03 |
|  | Corallinaceae | 50.88 | 1.27 | 7.62 | 0.52 |
| **ACA** | **Articulated coralline algae** |  |  |  |  |
|  | *Amphyroa* sp*.* | 7.36 | 0.60 | 6.94 | 0.51 |
|  | *Jania* sp*.* | 0.47 | 0.16 | 0.00 | 0.00 |
| **Macroalgae** | **Coarsely-branched algae** |  |  |  |  |
|  | *Asparagopsis taxiformis* | 0.31 | 0.18 | 0.06 | 0.03 |
|  | *Codium intertextum* | 0.06 | 0.02 | 0.42 | 0.06 |
|  | *Dictyosphaeria cavernosa* | 0.03 | 0.01 | 0.01 | 0.01 |
|  | *Gelidiella* sp*.* | 0.02 | 0.01 | 0.00 | 0.00 |
|  | *Gelidium* sp*.* | 0.24 | 0.05 | 0.12 | 0.03 |
|  | *Laurencia dendroidea* | 0.00 | 0.00 | 0.01 | 0.01 |
|  | *Pterocladiella capillacea* | 0.003 | 0.003 | 0.00 | 0.00 |
|  | **Foliose algae** |  |  |  |  |
|  | *Dictyopteris* spp. *& Dictyota* spp*.* | 0.00 | 0.00 | 2.41 | 0.30 |
|  | *Enteromorpha* sp*.* | 0.18 | 0.06 | 0.00 | 0.00 |
|  | *Ulva lactuca* | 3.52 | 0.37 | 0.03 | 0.01 |
|  | **Thick-leathery algae** |  |  |  |  |
|  | *Colpomenia sinuosa* | 0.09 | 0.03 | 0.16 | 0.05 |
|  | *Padina gymnospora* | 0.00 | 0.00 | 0.03 | 0.01 |
|  | *Sargassum* spp*.* | 0.08 | 0.07 | 43.64 | 1.50 |
|  | *Lobophora variegata* | 0.00 | 0.00 | 0.01 | 0.01 |
| **EAM** | **Epilithic algal matrix** |  |  |  |  |
|  | *Bryopsis* sp*.* | 0.18 | 0.05 | 0.01 | 0.00 |
|  | *Centroceras* sp*.* | 3.41 | 0.36 | 0.18 | 0.03 |
|  | *Ceramium* sp*.* | 0.82 | 0.17 | 0.05 | 0.02 |
|  | *Chaetomorpha* sp*.* | 0.01 | 0.01 | 0.00 | 0.00 |
|  | *Cladophora* sp*.* | 0.02 | 0.02 | 0.00 | 0.00 |
|  | *Hypoglossum hypoglossoides* | 0.61 | 0.13 | 6.56 | 0.62 |
|  | *Polysiphonia* sp*.* | 0.78 | 0.28 | 0.03 | 0.02 |
|  | *Spyridia filamentosa* | 0.17 | 0.12 | 0.00 | 0.00 |
|  | Multispecific turf | 49.59 | 4.10 | 60.22 | 3.30 |
| **Substrate** | **Uncolonized substrate** |  |  |  |  |
|  | Sand | 0.33 | 0.11 | 2.64 | 0.29 |
|  | Rubble | 0.25 | 0.05 | 0.29 | 0.04 |
|  | Bare rock | 6.87 | 0.44 | 0.15 | 0.03 |

Table 2s. Relative biomass of nominally herbivorous fish species at study sites in rocky reefs of Arraial do Cabo, RJ (Brazil) according to site and stratum (following Cordeiro *et al*., 2016).

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | **Abobrinha** | | | | | | **Pedra Vermelha** | | | | | |
| **Family** | **Species** | **MFG** | **Deep** | | | **Shallow** | | | **Deep** | | | **Shallow** | | |
|  |  |  | **Mean** | **s.d.** | **%** | **Mean** | **s.d.** | **%** | **Mean** | **s.d.** | **%** | **Mean** | **s.d.** | **%** |
| Acanthuridae | *Acanthurus bahianus* | D | 23.3 | 9.1 | 4.4 | 27.1 | 6.9 | 7.7 | 8.7 | 1.9 | 5.8 | 12.7 | 2.4 | 7.2 |
| Acanthuridae | *Acanthurus chirurgus* | D | 21.7 | 12.1 | 6.1 | 38.9 | 11.6 | 11.0 | 10.0 | 2.9 | 5.2 | 41.8 | 25.6 | 17.7 |
| Acanthuridae | *Acanthurus coeruleus* | A | 5.0 | - | 0.2 | 14.5 | 4.0 | 2.0 | 4.6 | 2.1 | 0.4 | 7.2 | - | 0.3 |
| Sparidae | *Diplodus argenteus* | O | 2.5 | 0.6 | 0.5 | 6.3 | 2.0 | 1.8 | 4.2 | 1.3 | 2.5 | 12.6 | 5.8 | 5.3 |
| Kyphosidae | *Kyphosus* spp. | A | 13.8 | - | 0.7 | 6.8 | 1.4 | 2.3 | 19.2 | 11.0 | 3.6 | 16.2 | 10.4 | 6.9 |
| Labridae | *Scarus zelindae* | D | 6.7 | 2.4 | 0.6 | 2.0 | 0.1 | 0.2 | 2.8 | 0.8 | 0.7 | 4.1 | 1.3 | 0.4 |
| Labridae | *Sparisoma axillare* | D | 4.7 | - | 0.2 | 5.1 | 2.6 | 0.5 | 2.9 | 0.1 | 0.3 | 2.1 | 1.0 | 0.5 |
| Labridae | *Sparisoma frondosum* | D | 3.5 | 1.5 | 0.3 | 3.7 | 0.7 | 0.4 | 3.3 | 1.7 | 0.8 | 2.0 | 0.4 | 0.7 |
| Labridae | *Sparisoma radians* | D | 1.9 | - | 0.1 | - | - | 0.0 | 2.7 | 0.6 | 0.8 | 0.7 | 0.3 | 0.1 |
| Labridae | *Sparisoma tuiupiranga* | D | 2.1 | 0.9 | 0.4 | 2.1 | 0.7 | 0.6 | 0.8 | 0.2 | 0.6 | 0.6 | 0.1 | 0.3 |
| Total |  |  | 11.1 | 3.4 | 13.6 | 14.0 | 2.9 | 25.7 | 5.5 | 0.9 | 21.6 | 11.9 | 3.6 | 40.9 |

MFG – Morpho-functional group. D – detritivore. A – algivore. O – omnivore



**Figure 1s.** Autocorrelation from nutrient concentration (a) and water temperature (b), and cross-correlation between nutrient concentration and water temperature (c) of Arraial do Cabo, RJ (Brazil).



**Figure 2s.** Cross-correlation between water temperature and dominant morpho-functional algae groups from control plots at shallow stratum (1-2 m) of Arraial do Cabo, RJ (Brazil) rocky reefs.



**Figure 3s.** Cross-correlation between nutrient concentration and dominant morpho-functional algae groups from control plots at deep stratum (5-6 m) of Arraial do Cabo, RJ (Brazil) rocky reefs.

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**Figure 4s.** Relative cover of macroalgae (MA) and articulate coralline algae (ACA) in two sites on rocky shore of Arraial do Cabo (RJ, Brazil) after the experimental period (205 days). Boxes define the median and the interquartile range (25% and 75%), with whiskers limiting the 95% quantile interval. Dots represent replicates.



**Figure 5s.** Effect size (Cohen’s d) for treatments of herbivores exclusion (cage = sea urchins and fish exclusion, fence = sea urchin exclusion only, and roof = fish exclusion only) versus controls for algal groups (MA = macroalgae, CCA = crustose coralline algae, ACA = articulate coralline algae, and EAM = epilithic algal matrix) on rocky shore of Arraial do Cabo (RJ, Brazil). Samples of sites were pooled together. Dots represent replicates, and the blue line is the regression line between time and effect size for each combination plotted.

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