*The following supplement accompanies the article*

# Size matters: macroalgal height influences the feeding response of coral reef herbivores

**A. S. Hoey***

**ARC Centre of Excellence for Coral Reef Studies and School of Marine and Tropical Biology, James Cook University, Townsville, Queensland 4811, Australia**

*Email: andrew.hoey@jcu.edu.au

*Marine Ecology Progress Series 411:299–302 (2010)*

## SUPPLEMENT

## TEMPORAL VARIATION IN REMOVAL RATES OF *SARGASSUM POLYCYSTUM*

Due to difficulties in estimating the size (or biomass) of the assays at various times throughout the 5 h experimental period, the total mass standardized bites were used as a proxy for the reduction in algal biomass. Total mass standardized bites was significantly related to the total algal biomass removed over the 5 h experimental period, and explained 87% of the variation in the algal mass removed across all assays ($r^2 = 0.87$, $F_{1,22} = 151.39$, $p < 0.001$). Therefore, to determine if the relative removal rates of *Sargassum polycystum* differed among thallus heights, sites, or time, a repeated measures ANOVA was used. The analysis was based on the mass standardized bites taken from each assay during five sequential 1 h intervals (expressed as a proportion of the total mass standardized bites taken from each assay). Proportions were used to account for differences in the size of each assay and allow relative feeding rates to be compared among assays of different sizes. The proportional data was arcsine-square root transformed to improve normality and homoscedasticity.

The relative rates of removal were influenced by time (or h) during each deployment (Table S1), with the majority of feeding (76.8 to 81.9 %) being recorded within the first 2 h of each deployment. There was no effect of thallus height, site, or any interaction between time and thallus height, demonstrating that the rate of feeding, and subsequently reduction in algal biomass, did not differ among thallus heights. This consistency of feeding among the assays of the four thallus heights suggests that the relative differences in algal height/size were likely to be maintained throughout the experimental period.

Table S1: Summary of repeated measures ANOVA comparing the relative rate of feeding on *Sargassum* among thallus heights, sites, and time. Proportion of mass standardized bites was arcsine-square root transformed. Significant effects are shown in bold ($p < 0.05$)

| Source of variation | SS | df | MS | *F* | p |
|---|---|---|---|---|---|
| Height | 0.00063 | 3 | 0.00021 | 0.034 | 0.991353 |
| Site | 0.00155 | 1 | 0.00155 | 0.248 | 0.625434 |
| Height _ Site | 0.02471 | 3 | 0.00824 | 1.320 | 0.302525 |
| Residual | 0.09983 | 16 | 0.00624 | | |
| **Time** | **6.87963** | **4** | **1.71991** | **23.851** | **0.000000** |
| Time _ Height | 0.63920 | 12 | 0.05327 | 0.739 | 0.708694 |
| Time _ Site | 0.34930 | 4 | 0.08732 | 1.211 | 0.314878 |
| Time _ Height _ Site | 0.39617 | 12 | 0.03301 | 0.458 | 0.931667 |
| Error | 4.61501 | 64 | 0.07211 | | |

## TEMPORAL VARIATION IN FEEDING BY *NASO UNICORNIS* AND *KYPHOSUS VAIGIENSIS*

To determine if either *Naso unicornis* or *Kyphosus vaigeinsis* shifted their feeding preferences during the 5 h experimental period 2 repeated measures ANOVAs were used to compare feeding among thallus heights, sites, and time. The analyses were based on the mass standardized bites taken by each species during 5 sequential 1 h intervals, with a separate analysis being conducted for each species. Mass standardized bites were $\sqrt[4]{}$ transformed to improve normality and homoscedasticity.

The feeding of *Naso unicornis* was influenced by time, while the feeding of *Kyphosus vaigiensis* was influenced by thallus height and time (Table S2). Both species took a greater number of mass standardized bites during the first 2 h than the last h of each 5 h period (Fig. S1). *K. vaigiensis* also took significantly fewer bites from the shortest (10 cm) assays than the larger (20 to 80 cm) assays throughout the 5 h period. There was no significant interaction between thallus height and time indicating that neither species shifted their feeding preferences during the experimental period.

Table S2: Summary of repeated measures ANOVAs comparing the feeding of (a) *Naso unicornis*, and (b) *Kyphosus vaigiensis* among thallus heights, sites, and time. Mass standardized bites were $^{4}\sqrt{}$ transformed. Bonferroni correction was used to allow for multiple comparisons. Significant effects are shown in bold ($p < 0.025$)

| Source of variation | SS | df | MS | *F* | p |
|---|---|---|---|---|---|
| **(a) *N. unicornis*** | | | | | |
| Height | 8.5775 | 3 | 2.8592 | 0.9105 | 0.459334 |
| Site | 0.7749 | 1 | 0.7749 | 0.2468 | 0.626569 |
| Height _ Site | 7.0331 | 3 | 2.3444 | 0.7465 | 0.541014 |
| Residual | 47.1055 | 15 | 3.1404 | | |
| **Time** | **57.5412** | **4** | **14.3853** | **12.5502** | **0.000000** |
| Time _ Height | 12.5863 | 12 | 1.0489 | 0.9151 | 0.537742 |
| Time _ Site | 2.2351 | 4 | 0.5588 | 0.4875 | 0.744850 |
| Time _ Height _ Site | 11.6687 | 12 | 0.9724 | 0.8483 | 0.601707 |
| Error | 68.7733 | 60 | 1.1462 | | |
| **(b) *K. vaigiensis*** | | | | | |
| **Height** | **60.7377** | **3** | **20.2459** | **12.7344** | **0.000211** |
| Site | 2.4172 | 1 | 2.4172 | 1.5204 | 0.236539 |
| Height _ Site | 14.2427 | 3 | 4.7476 | 2.9861 | 0.064549 |
| Residual | 23.8480 | 15 | 1.5899 | | |
| **Time** | **93.2754** | **4** | **23.3188** | **16.1175** | **0.000000** |
| Time _ Height | 23.0935 | 12 | 1.9245 | 1.3301 | 0.226056 |
| Time _ Site | 4.2315 | 4 | 1.0579 | 0.7312 | 0.574236 |
| Time _ Height _ Site | 4.5025 | 12 | 0.3752 | 0.2593 | 0.993212 |
| Error | 86.8082 | 60 | 1.4468 | | |

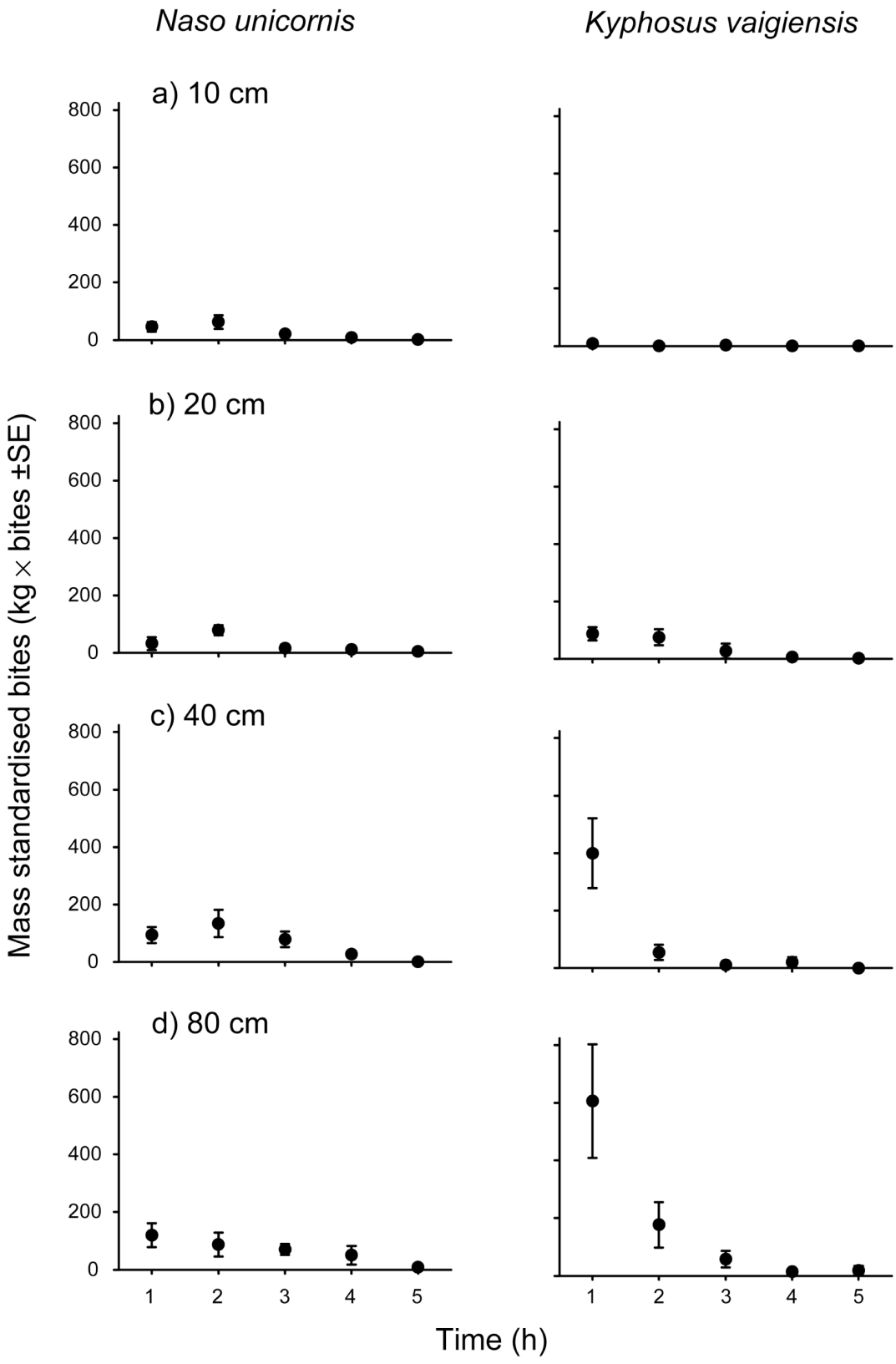


Fig. S1. Temporal variation in feeding by *Naso unicornis* and *Kyphosus vaigiensis* on *Sargassum polycystum* assays of varying heights: (a) 10 cm, (b) 20 cm, (c) 40 cm, and (d) 80 cm. Mass-standardized bites are the product of fish body mass and the number of bites taken by each individual fish

## VARIATION IN REMOVAL RATES OF *SARGASSUM POLYCYSTUM*

Table S3. Summary of a 3-factor ANOVA comparing the removal rates of *Sargassum polycystum* among thallus heights, sites, and days. The proportion of algal biomass removed was arcsine-square root transformed. Significant effects are shown in bold ($p < 0.05$)

| Source of variation | SS | df | MS | *F* | p |
|---|---|---|---|---|---|
| **Height** | **0.244** | **3** | **0.081** | **14.12** | **0.004** |
| Site | 0.069 | 1 | 0.069 | 10.37 | 0.084 |
| Day | 0.041 | 2 | 0.021 | 2.89 | 0.147 |
| Height _ Site | 0.040 | 3 | 0.013 | 0.87 | 0.509 |
| Height _ Day | 0.035 | 6 | 0.006 | 0.38 | 0.870 |
| Day _ Site | 0.013 | 2 | 0.007 | 0.44 | 0.665 |
| **Height _ Site _ Day** | **0.092** | **6** | **0.015** | **3.14** | **0.011** |
| Residual | 0.233 | 48 | 0.005 | | |

## SELECTIVITY FOR MACROALGAL HEIGHT

To determine if the 3 dominant herbivore species displayed a preference for any particular thallus height, a resource selection ratio (the forage ratio: Savage 1931 in Manly et al. 2002) was calculated. The forage ratio indicates the degree to which feeding on each thallus height deviated from expectation based on its availability and was calculated for each species using the following equation:

$$\text{Forage ratio } (w_i) = o_i / \pi_i$$

where $o_i$ is the number of mass standardized bites from macroalga height *i*, as a proportion of the total mass standardized bites recorded by that species from macroalgae of all heights; and $\pi_i$ is the proportion of the total algal biomass belonging to macroalgae of height *i*. To determine if selection was significant, Bonferroni-corrected 95% confidence limits around the selection ratio estimates were calculated using the following equation:

$$\text{se}(w_i) = \sqrt{[o_i (1 - o_i) / (\mu_+ \pi_i^2)]}$$

where $\mu_+$ is the total number of bites recorded by that species. When the macroalga of height *i* was used in proportion to its availability the selection ratio ± 95% confidence interval (CI) encompassed 1; when used more than its availability the ratio ± 95% CI was >1; and when the macroalga was avoided the ratio ± 95% CI was <1.

The 3 dominant herbivores displayed differing patterns of selectivity with respect to the 4 *Sargassum* heights (Fig. S2). *Naso unicornis* displayed a strong positive selection for the shortest (10 cm) *Sargassum*, and tended to feed less on the taller *Sargassum*. In contrast, *Kyphosus vaigiensis* avoided the shortest *Sargassum*, and displayed a slight but significant preference for *Sargassum* of the two greatest heights (Fig. S2). *Siganus doliatus* displayed no preference with respect to the height of the *Sargassum*.

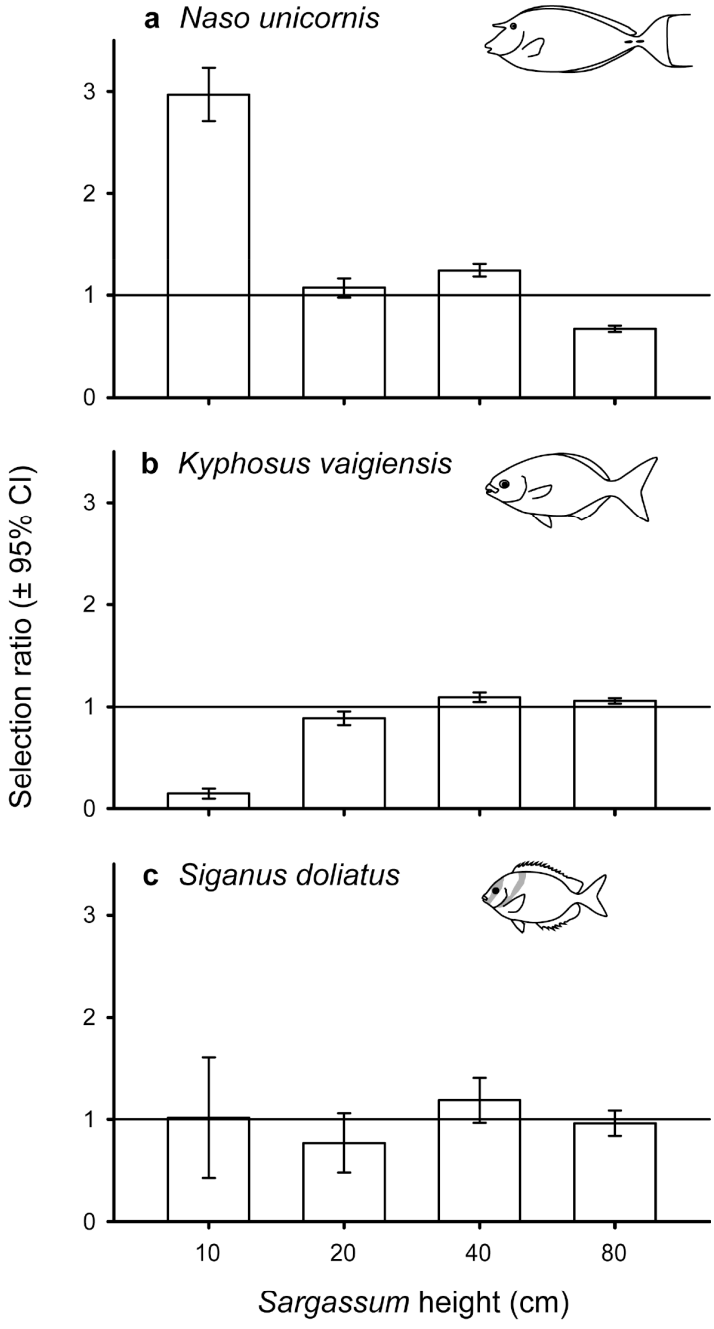


Fig. S2. Feeding selectivity on assays of different heights by (a) *Naso unicornis*, (b) *Kyphosus vaigiensis*, and (c) *Siganus doliatus*. A selection index of 1 indicates the assay was consumed in proportion to its availability or biomass; values >1 indicate positive selection; values <1 indicate negative selection or avoidance

## LITERATURE CITED

Manly BFJ, McDonald LL, Thomas DL, McDonald TL, Erickson WP (2002) Resource selection by animals: statistical design and analysis for field studies. Kluwer, Dordrecht