Dietary habits of grazers influence their suitability as biological controls of fouling macroalgae in ex situ mariculture

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Abstract
The dietary habits of the sea urchin Salmacis sphaeroides and the gastropod Trochus maculatus in ex situ mariculture were examined. Fouling algal assemblages on terracotta tiles were exposed to the grazers and compared. Except for Day 0, the assemblages on Days 2, 13 and 27 differed significantly across treatments. S. sphaeroides rapidly consumed most algae, leaving an assemblage dominated by turf algae and bare tile. T. maculatus primarily fed on green filamentous algae, resulting in an even distribution of other algal functional groups, while control tiles were dominated by green filamentous algae. Using three representative fouling algae species (Bryopsis corymbosa, Hypnea spinella and Lobophora variegata), the consumption rates of both grazers and dietary preferences of S. sphaeroides were examined through a single-diet and a choice experiment respectively. The single-diet experiment revealed differential algal consumption rates for S. sphaeroides (H. spinella = B. corymbosa > L. variegata) and T. maculatus (B. corymbosa > H. spinella = L. variegata). The choice experiment showed that S. sphaeroides preferred H. spinella over the other two species. These experiments highlighted the importance of understanding the dietary habits of grazers as this has direct implications on their effectiveness as biological controls of fouling macroalgae in mariculture.

Keywords: ex situ mariculture, grazing, preference, Salmacis sphaeroides (Linnaeus), Trochus maculatus (Linnaeus)

Introduction
Herbivores profoundly influence the structure and function of primary producers in various marine ecosystems by exerting a top-down control on macrophyte communities (Burkepile & Hay 2006) and influencing fundamental processes such as bioerosion and habitat creation (Borowitzka 1981; Tribollet & Golubic 2011). It follows that a reduction in the numbers of grazers would lead to significant increases in the abundance of primary producers such as algae, as exemplified by numerous herbivore exclusion studies (see review by Poore, Campbell, Coleman, Edgar, Jormalainen, Reynolds, Sotka, Stachowicz, Taylor, Vanderklift & Duffy 2012). In mariculture facilities, the health and survival of the target cultured organisms can be affected if algae are allowed to proliferate. For example, filamentous algae can smother juvenile tridacnids and compete with them for nutrients (Ellis 2000), while noxious blooms can render shellfish toxic (Shumway 1990). Even the culture of commercially important algae is beset with complications, as competition from epiphytes can result in contamination and reduced harvests (Briggs & Funge-Smith 1993).

Although algae are commonly eradicated using physical (e.g. manual removal) and chemical (e.g. anti-foulants) means, these approaches are often labour- or cost-intensive, and may not be entirely effective. Substantial costs are incurred when nets in salmon farms have to be replaced frequently (Hodson, Lewis & Burke 1997), and manual removal of fouling algae and invertebrates at a
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Aquaculture Research, 2013, 1–9

coral nursery are estimated to require 60 man-hours per month or even more for nurseries sited in high sediment environments (Shafir, Edwards, Rinkevich, Bongiorni, Levy & Shaish 2010). While anti-fouling paints have the potential to reduce maintenance regimes, they can be expensive and may affect the target cultured organisms (Shafir, Abady & Rinkevich 2009; Braithwaite & McEvoy 2005). As the problem of algal fouling is exacerbated in the tropics where environmental conditions are more constant and conducive for the rapid growth and proliferation of macroalgae (Cheah & Chua 1979), the introduction of herbivores in mariculture as controls of pest algae may instead help to defray such costs (Lafferty & Kuris 1996).

Widely distributed on tropical reefs, rocky shores and coastal defence structures (e.g. Colquhoun 2001; Misra & Kundu 2005; Lee, Tan & Sin 2009), Trochus spp. gastropods are frequently employed as grazers in mariculture (Bell & Gervis 1999; Clarke, Komatsu, Bell, Lasi, Oengpepa & Leqata 2003; Omori 2005). Temnopleurid urchins, common in seagrass beds and rocky coasts, are generalist feeders (Kikuchi 1974; James 1982; Klumpp, Salit-a-Espinosa & Fortes 1993; Tsuchiya, Nishihira, Poung-in & Choohabandit 2009), but are not known to be used as biological controls. These studies highlight the potential of using members of these taxa as biological controls of fouling algae to reduce the cost and effort of the upkeep of tropical mariculture systems. This is because mariculture research thus far has focused mainly on the cultured organisms, while few have specifically investigated the suitability of a particular grazer in dealing with the problem of algal fouling. The first of three experiments in this study aimed to determine the effects of Trochus maculatus (Linnaeus 1758) and Salmacis sphaeroides (Linnaeus 1758) on algal communities that have established on terracotta tiles. The objective of the second experiment was to quantify the suitability of S. sphaeroides in dealing with the problem of algal fouling (Cheah & Chua 1979), and categorizing them based on the following functional groups adapted from Villanueva, Edwards and Bell (2010): (i) green filamentous (GFI), (ii) red corticated (RCO), (iii) brown foliose (BFO), (iv) crustose coralline algae (CCA), (v) green turf algae (≤ 0.5 cm) (TURF) and (vi) bare tile surface (TILE).

Effects of grazers on fouling algal communities in ex situ mariculture

Terracotta is widely used in scleractinian recruitment studies and as substrate for facilitating the transplantation of hard corals onto reefs (Villanueva, Yap & Montaño 2006; Guest, Heyward, Omori, Iwao, Morse & Boch 2010), and, like the fibreglass material of mariculture tanks, can also be colonized easily by algae. Square terracotta tiles (5 cm × 5 cm × 1 cm) were biologically conditioned in flow-through tanks for at least 6 months to allow an assemblage of macroalgae to develop over them. Forty-two tiles with more than 90% algal cover on the top surfaces were used for this experiment, with two tiles placed in each of 21 perforated polyethylene tanks (18 cm × 18 cm × 9 cm). The grazers were pre-starved for 24 h and the fresh weights were measured using an electronic weighing balance (Ohaus SP602, Ohaus Corporation, Pine Brook, NJ, USA) to standardize the total herbivore biomass in each treatment. Each replicate treatment contained either one S. sphaeroides, three T. maculatus or was a grazer-free control (n = 7 per treatment). The tanks were randomly arranged in a 560-litre outdoor flow-through sand-filtered seawater tank. Over the course of the experiment, mean daily temperature in the seawater tank as measured with a HOBO Pendant® Temperature/Light Data Logger (Onset Computer Corporation Inc., Pocasset, MA, USA) ranged 27.3–28.3°C.

The tiles were monitored over 4 weeks and the algal cover on the tiles was analysed at four time-points: Day 0, Day 2, Day 13 and Day 27. Photographs of each tile were taken and the algal community was quantified by generating 50 random stratified points with the software Coral Point Count with Excel extensions (Kohler & Gill 2006) and categorizing them based on the following functional groups adapted from Villanueva, Edwards and Bell (2010): (i) green filamentous (GFI), (ii) red corticated (RCO), (iii) brown foliose (BFO), (iv) crustose coralline algae (CCA), (v) green turf algae (≤ 0.5 cm) (TURF) and (vi) bare tile surface (TILE).
Using these variables, a Bray Curtis similarity matrix of tile algal communities was constructed. A non-metric multidimensional scaling (nMDS) ordination of the similarity matrix was used to visualize the between-treatment and between-time-point differences of the algal communities. One-way analysis of similarities (ANOSIM) was used to test for differences among treatments at each time-point. Similarity of percentages analysis (SIMPER) was performed to quantify the level of similarity within and between treatments/time and to identify the variables contributing to the dissimilarities. The nMDS ordination plot was constructed using R 2.14.2 while all other analyses were performed using PRIMER v6.16 (Clarke & Gorley 2006).

Algal consumption rates of Salmacis sphaeroides and Trochus maculatus

The preceding experiment demonstrated that red corticated, green filamentous and brown foliose algae were the most prevalent types of fouling algae in mariculture tanks (see Fig. 2). To determine the grazers’ consumption rates of these algae as a measure of their edibility (Nicotri 1980), a ‘single diet’ experiment was set up. Hypnea spinella (C.Agardh) Kütz 1847, Bryopsis corymbosa (J.Agardh 1842) and Lobophora variegata (J.V.Lamouroux) Womersley ex E.C.Oliveira 1977, which best represented the three algal forms, respectively, were collected from the natural shore at Tanjung Rimau, Sentosa Island, Singapore (1°15′34″N, 103°48′24″E). Two pieces of 10 cm × 10 cm plastic mesh (mesh sizes of 2 cm and 0.7 cm) were used to sandwich 1.5 g of each algal type, forming an “algae packet” which maintained the thallus as a clump but still allowed the animals in this study to come into contact with the algae. Two packets with the same algae species were then secured to the base of a polyethylene cage (21 cm × 12 cm × 12 cm), which prevented stray thalli from floating away and the grazer from escaping. The grazers were pre-starved for 24 h and only one individual was introduced into each cage to avoid interspecific interactions (Peterson & Renaud 1989). In total, six replicate tanks of each treatment (S. sphaeroides, T. maculatus or control) were randomly arranged in a 560-litre tank with flow-through filtered seawater. After 24 h, the remaining algae in all the baskets were blotted dry and the fresh weight was measured.

The consumption rate for a particular alga was defined as the loss in fresh weight of the alga after 24 h of grazing. To account for autogenic changes (Peterson & Renaud 1989), the mean consumption rate of algae X (B. corymbosa, L. variegata or H. spinella) by grazer Y (S. sphaeroides or T. maculatus), estimated mean of $C_{X,Y}$, was calculated using the grazer-free controls as a correction factor:

$$C_{X,Y} = -\left(\frac{\Delta \bar{m}_{X,Y}}{\Delta \bar{m}_{X,\text{Control}}}\right)$$

where $\Delta \bar{m}$ refers to the change in mean algal mass (after grazing – before grazing).

The estimated variance of the corrected consumption rate was calculated as:

$$\text{Var}(C_{X,Y}) = \text{Var}(\Delta \bar{m}_{X,Y}) + \text{Var}(\Delta \bar{m}_{X,\text{Control}})$$

The corrected mean consumption rates of the two grazers for the three algae species was then compared using one-way ANOVA and Student-Newman-Keuls (SNK) post hoc test (GMAV5).

Dietary preferences of Salmacis sphaeroides

Results from the single-diet experiment revealed that the consumption rates of H. spinella and L. variegata, unlike that of B. corymbosa, were extremely low in the presence of T. maculatus (see Fig. 3) and therefore its dietary preferences were not examined. S. sphaeroides, however, was subjected to a choice experiment to investigate its preferences as substantial amounts of the three algae were consumed. Following the same protocol in the preceding section, algae packets were made but with each containing three grams of algae. Each pre-starved S. sphaeroides was presented a choice of two algae species and all possible pairwise combinations were offered ($n = 8$ for each combination). Grazer-free controls for each combination were also set up to correct for autogenic changes in algal mass. After 24 h, the remaining algae were blotted dry and fresh weight was measured.

For each pair of algae (A and B) presented to S. sphaeroides (S), the corrected mean consumption rates ($C_{A,SA}$ and $C_{B,SB}$) and the corresponding variance estimates were calculated using equations (1) and (2). The dietary preference of S. sphaeroides for the three algae species was analysed using a two-phase mosaic design (Underwood &
Clarke 2005) to test the differences in the proportion of the algae consumed in the choice experiment against that when the food choices were presented alone.

The proportion of Algae A and B consumed in the single-diet experiment, \( R_{A/B} \), was calculated as follows:

\[
R_{A/B} = \frac{C_{A,S}}{C_{B,S}}
\]

(3)

The estimated variance of \( R_{A/B} \) was calculated using Taylor’s Approximation of Variances:

\[
\text{Var}(R_{A/B}) = \left( \frac{C_{A,S}}{C_{B,S}} \right)^2 \times \left[ \frac{\text{Var}(C_{A,S})}{C_{A,S}^2} + \frac{\text{Var}(C_{B,S})}{C_{B,S}^2} \right]
\]

(4)

Likewise, the mean and estimated variance of proportion of Algae A and B consumed in the choice experiment, \( R'_{A/B} \), was calculated using equation (3) and (4) respectively.

Both the estimated means and variances of \( R_{A/B} \) and \( R'_{A/B} \) were then transformed to normality using Geary-Hinkley transformation (Hayya, Armstrong & Gressis 1975) and t-test was used to analyse for differences between \( R_{A/B} \) and \( R'_{A/B} \). The dietary preference of \( S. \) sphaeroides for either Algae A or B was inferred when \( R'_{A/B} \) was significantly different from \( R_{A/B} \).

**Results**

**Effects of grazers on fouling algal communities in ex situ mariculture**

There were no significant differences in algal communities among tiles of all treatments on Day 0 (ANOSIM, \( R = 0.04 \), \( P = 0.22 \)). On Days 2, 13 and 27, however, the algal communities among the three treatments differed significantly (\( R = 0.0707, 0.794 \) and 0.923, respectively; \( P < 0.01 \) for all between-treatment pairwise tests).

At the end of the experiment, the ungrazed control tiles were GFI-dominated, \( S. \) sphaeroides-grazed tiles were TILE-dominated, while the algal communities on \( T. \) maculatus-grazed tiles were more evenly distributed (Fig. 1).

Two days into the experiment, tiles grazed by \( S. \) sphaeroides were nearly devoid of GFI (0.3%) (Fig. 2a), while the proportion of GFI on tiles grazed by \( T. \) maculatus had decreased from 34% to 12% (Fig. 2b). RCO on \( S. \) sphaeroides-grazed tiles declined from 22% to 8% between Day 0 and Day 2 (Fig. 2a), but remained similar on \( T. \) maculatus-grazed tiles (23% and 25% on Day 0 and 2 respectively) (Fig. 2b). TURF cover increased on the \( S. \) sphaeroides-grazed tiles with the reduction in GFI and RCO (Fig. 2a), as BFO increased slightly from 6% to 11%. Algal communities on the control tiles were not significantly different between Day 0 and Day 2 (Fig. 2c).
By Day 13, tiles grazed by both herbivores differed from each other due to the proportions of GFI and RCO (Fig. 2a, b). RCO was completely removed from *S. sphaeroides*-grazed tiles and TILE increased to 45% (Fig. 2a). On *T. maculatus*-grazed tiles, GFI decreased to 0.7% with a corresponding increase in TILE (35%), while RCO remained relatively constant (21%) (Fig. 2b). Highly dissimilar to herbivore-grazed tiles, more than half of the tile area for the controls was covered by GFI (52%), while TILE had declined markedly (0.1%) (Fig. 2c).

By Day 27 (Fig. 2), the algal cover on *S. sphaeroides*-grazed tiles sharply declined, and TILE dominated at 72%. The algal community on *T. maculatus*-grazed tiles was similar to that on Day 13 with slight changes in BFO (13% to 14%), RCO (21% to 26%) and TILE (35% to 33%). The final proportion of GFI on control tiles was 68%, resulting in an algal community highly dissimilar from the herbivore-grazed tiles.

Algal consumption rates of *Salmacis sphaeroides* and *Trochus maculatus*

The corrected mean consumption rates of *S. sphaeroides* over 24 hours (Fig. 3) were significantly different among the three species of algae (*F*<sub>2,15</sub> = 9.77, *P* < 0.05). Post hoc SNK tests showed that the consumption rates of *H. spinella* (2.64 ± 0.26 g day<sup>-1</sup>) and *B. corymbosa* (2.01 ± 0.25 g day<sup>-1</sup>) were not significant, but were both significantly higher than *L. variegata* (1.22 ± 0.15 g day<sup>-1</sup>). The corrected mean consumption rates (± SE) of *T. maculatus* for the three algae species also differed significantly (*F*<sub>2,15</sub> = 8.98, *P* < 0.05), with more *B. corymbosa* consumed (0.83 ± 0.16 g day<sup>-1</sup>) than *L. variegata* (0.31 ± 0.11 g day<sup>-1</sup>) and *H. spinella* (0.1 ± 0.11 g day<sup>-1</sup>).

**Dietary preference of *Salmacis sphaeroides***

The dietary preferences of *S. sphaeroides* varied according to the choices of algae offered (Table 1). When *S. sphaeroides* was presented with *L. variegata* and *B. corymbosa*, it did not prefer an algae species

![Figure 2](image1.png)  
*Figure 2* Change in percentage composition of algal communities on tiles grazed by *Salmacis sphaeroides* (a), *Trochus maculatus* (b) and control tiles (c) over 4 weeks. (BFO = brown foliose algae, RCO = red corticated algae, GFI = green filamentous algae, TURF = green turf algae, CCA = crustose coralline algae, TILE = bare tile surface.)

![Figure 3](image2.png)  
*Figure 3* Corrected mean consumption rates (± SE) of *Hypnea spinella*, *Bryopsis corymbosa* and *Lobophora variegata* by *Salmacis sphaeroides* and *Trochus maculatus*. Combinations sharing a letter (a, b, c, d) differ significantly in consumption rates at *P* = 0.05.

*T. maculatus*-grazed tiles was similar to that on Day 13 with slight changes in BFO (13% to 14%), RCO (21% to 26%) and TILE (35% to 33%). The final proportion of GFI on control tiles was 68%, resulting in an algal community highly dissimilar from the herbivore-grazed tiles.
more than the other \((t_{12} = -0.31, P = 0.765)\) and the corrected mean consumption rates (± SD) were \(0.73 ± 0.42 \, \text{g day}^{-1}\) and \(1.60 ± 0.61 \, \text{g day}^{-1}\) respectively. However, \(S. \, sphaeroides\) preferred \(H. \, spinella\) over \(B. \, corymbosa\) \((t_{12} = 3.24, P < 0.01)\) and the corrected mean consumption rates (± SD) were \(2.76 ± 0.24 \, \text{g day}^{-1}\) and \(1.30 ± 0.59 \, \text{g day}^{-1}\) respectively. \(S. \, sphaeroides\) also preferred \(H. \, spinella\) over \(L. \, variegata\) \((t_{12} = 4.81, P < 0.001)\), with corrected mean consumption rates (± SD) of \(2.50 ± 0.40 \, \text{g day}^{-1}\) and \(0.37 ± 0.29 \, \text{g day}^{-1}\) respectively.

**Discussion**

A variety of herbivores has been introduced to curb the proliferation of macroalgae in mariculture, such as siganids, gastropods, echinoids and hermit crabs, which have been used with varying degrees of success (Hasse 1974; Ellis 2000; Lodeiros & Garcia 2004; Petersen, Latreveer & Schuhmacher 2005). The results from this study thus underscore the importance of understanding the dietary habits of grazers if they are to be employed as efficient biological controls in ex situ mariculture facilities.

Herbivorous grazers are instrumental in shaping the community structure of algal assemblages in the natural environment (Sammarco 1983; Hixon & Brostoff 1999; Burkepille & Hay 2006; Bandaldo & Bellwood 2011). The first experiment showed that herbivory can also modify fouling algal communities in an ex situ setting. \(T. \, maculatus\) and \(S. \, sphaeroides\) were able to reduce the overall amount of algae on terracotta tiles which they had been introduced to, but the resultant macroagal communities varied depending on the choice of the grazer. The depletion of GFI and reduction in TURF, along with the corresponding increase in the proportion of TILE and other algal functional groups on \(T. \, maculatus\)-grazed tiles corroborated with results from other studies on the feeding habits of the \(T. \, maculatus\) spp. gastropods, where individuals co-cultured with giant clams (Clarke et al. 2003) or in the aquarium trade (Venkatesan 2010) were more effective at reducing filamentous algae than other algal forms. In contrast, \(S. \, sphaeroides\) appeared to have a less specific diet, decimating green filamentous and red corticated forms within 7 days. Only upon the elimination of GFI and RCO did BFO gradually decrease. The proportion of CCA on \(S. \, sphaeroides\)-grazed tiles which hovered between 6% and 16% was consistent to other studies which describe the ability of urchins to ultimately maintain the cover of CCA in grazed areas (Ayling 1981; Fletcher 1987). These findings are analogous to the observations of spatial reversal of macroalgal abundance in coral reefs, from a stable state dominated by crustose coralline algae to that of filamentous and foliose macroalgae, after a series of mass urchin mortalities (Schiebling 1986; Hughes, Reed & Boyle 1987).

In the single-diet and choice experiments, the rates of algal consumption differed for \(T. \, maculatus\) and \(S. \, sphaeroides\). \(T. \, maculatus\) consumed significantly more \(B. \, corymbosa\) than \(H. \, spinella\) and \(L. \, variegata\). The extremely low consumption rates for \(L. \, variegata\) by \(T. \, maculatus\) were expected as the presence of phenolic and lipophilic compounds in the brown algae generally render it unpalatable to marine gastropods (Steinberg 1988; Steinberg & Paul 1990). Although \(H. \, spinella\) is valued for its high nutritional content, ease of handling, and commonly used as feed in mariculture (Viera, Goméz Pinchetti, Courtois de Vicose, Bilbao, Suárez, Harouna & Izquierdo 2005), \(T. \, maculatus\) in this study grazed relatively little of this algae species. \(B. \, corymbosa\), on the other hand, may contain secondary metabolites as is the

**Table 1** Proportion of consumption rates for single-diet and choice experiments, for all pairwise algal combinations presented to \(S. \, sphaeroides\) over 24 h. \(R_{A/B}\) and \(R'_{A/B}\) are the proportions of consumption rates between Algae A and B, in the single-diet experiment and choice experiment respectively.

<table>
<thead>
<tr>
<th>Combination</th>
<th>(R_{A/B})</th>
<th>(R'_{A/B})</th>
<th>(p_T)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Lobophora , variegata)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Bryopsis , corymbosa)</td>
<td>0.957</td>
<td>1.04</td>
<td>n.s.</td>
</tr>
<tr>
<td>(Bryopsis , corymbosa)</td>
<td>0.986</td>
<td>0.484</td>
<td>*</td>
</tr>
<tr>
<td>(Hypnea , spinella)</td>
<td></td>
<td>0.166</td>
<td>**</td>
</tr>
</tbody>
</table>

\(p_T\) values presented here are the results of a t-test between \(R_{A/B}\) and \(R'_{A/B}\) after Geary–Hinkley transformation (n.s. = not significant; *\(P < 0.01\); **\(P < 0.001\)).
case with its congenerics, but which do not deter grazers adequately as well (Paul, Nelson & Sanger 1990). The stark preference of *T. maculatus* for *B. corymbosa* over *H. spinella* and *L. variegata* was thus likely attributable to the gastropod’s rhidoglossan radula – the feeding apparatus of all other archaeogastropods which works more efficiently on algae with softer thalli (Steneck & Watling 1982; Lambrinidis, Luong-Van Thin & Renaud 1997). It follows then, that corticated *H. spinella* and leathery *L. variegata*, which are structurally tougher and have additional levels of grazing difficulty to archaeogastropods (Steneck & Watling 1982; Padilla 1985), were consumed to a lesser extent.

In line with the generalist feeding habits of *S. sphaeroides* (Klumpp et al. 1993; Tsuchiya et al. 2009), the results also showed that all three species of algae were fairly palatable to *S. sphaeroides*, and their morphological and chemical defences appeared insufficient to deter grazing by *S. sphaeroides* (Steinberg 1986; Coen & Tanner 1989; Paul et al. 1990; Granado & Caballero 2001). The difference in consumption rates of the algae (*H. spinella* > *B. corymbosa* > *L. variegata*) in the single-diet experiment may be attributed to the higher organic content per unit weight (dry weight/fresh weight) of *L. variegata* than *H. spinella* and *B. corymbosa* (unpublished data). The urchin may thus require less of *L. variegata* compared with the other two species in its diet. When presented with a choice of food, however, *S. sphaeroides* displayed significant preferences for *H. spinella* over *L. variegata* and *B. corymbosa*, as *H. spinella* is highly nutritious and palatable, with high protein content and low levels of phenolic metabolites (Granado & Caballero 2001; Viera et al. 2005). The possibility exists that *S. sphaeroides*, like other urchins also feeds preferentially to enhance fitness (Vadas 1977; Lemire & Himmelman 1996). Although it consumed more *B. corymbosa* than *L. variegata* in the single-diet experiment, the lack of preference for one alga over the other in the choice experiment suggests that it feeds on non-preferred algae to survive when the preferred foods are scarce.

Both animals were able to remove fast-growing algae that can blanket culture systems and smother other organisms, albeit with varying efficacies. The present study has refined the use of *Trochus* spp. gastropods as biological controls by quantifying the effects of *T. maculatus* on surfaces fouled by macroalgal communities and examining the ability of the gastropod to consume specific algal types. *Trochus maculatus*’s grazing efficiency was reinforced by its strict dietary preference of filamentous algae. This showed that *T. maculatus* would be more useful in controlling the proliferation of filamentous green algae than other algae types in mariculture systems. The feasibility of deploying *Salmacis sphaeroides* as a biological control in inland mariculture facilities was also highlighted. Its preference for green filamentous and red corticated algae was evident from the rate at which it eradicated these fast-growing algal forms, effectively controlling the algal community on the substrates. It was noteworthy that its voracious appetite also extended to brown foliose algae such as *L. variegata*, which is usually unpalatable to other herbivores (Steinberg & Paul 1990). There is general receptivity to the presence of CCA in culture tanks as they can increase the settlement and metamorphosis of various marine larvae (Morse & Hooker 1979; Morse, Iwao, Baba, Shimoike, Hayashibara & Omori 1996) and inhibit the growth of other algae without the presence of herbivores (Johnson & Mann 1986). As tiles grazed by *S. sphaeroides* and *T. maculatus* have relatively stable proportions of CCA, it appears that employing these grazers in inland mariculture facilities can also facilitate the maintenance and proliferation of CCA, thus benefiting the cultured organisms.

Clearly, the dietary habits of grazers can shape algal assemblages in inland mariculture facilities, but due consideration of their suitability as biological controls should be given prior to deploying them. Interactions between grazers and cultured organisms have been shown to result in physical damage (Forsman, Rinkevich & Hunter 2006) or unintended consumption of the latter (Shacklock & Doyle 1983). Hence, future studies should specifically examine the effects of these grazers on the health of the cultured organisms, as well as optimize techniques to reduce any potential damage from such interspecific interactions.

**Acknowledgments**

We would like to thank Dr A. J. Underwood for the discussions on statistical analyses, members of the Reef Ecology Laboratory and Experimental Marine Ecology Laboratory (National University of Singapore), as well as staff of the Tropical Marine Science Institute for logistical assistance. This study was supported by research grant number R-347-000-105-490 and conducted in partial
fulfilment of the PhD requirements for Toh Tai Chong.

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