Comparison of condition index in the green-lipped mussel *Perna viridis* between Sebatu and Pasir Panjang, Peninsular Malaysia

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Abstract

The condition index (which relates to the tissue dry weight to shell volume) of the green-lipped mussel *Perna viridis* was investigated at Sebatu in Melaka and Pasir Panjang in Negri Sembilan from September 2003 to February 2004. Monthly samples of *P. viridis* were collected from culturing rafts at both sites. Variations in the average monthly condition index (CI) of *P. viridis* ranged from 21.06 to 26.72 g cm⁻³ and 15.18 to 19.41 g cm⁻³ in Sebatu and Pasir Panjang, respectively. Salinity values were lowest in November between 27.93 to 28.10 ppt in Sebatu and Pasir Panjang, respectively. Salinity then started increasing gradually until it reached 33.26 ppt in Sebatu and 31.23 ppt in Pasir Panjang in the month of February. Chlorophyll a in Pasir Panjang showed higher fluctuation, ranging from 2.93 to 14.39 mg/L, while in Sebatu the fluctuations were lower and ranged between 7.70 and 9.37 mg/L. Rapid decline in CI values were recorded during January in Sebatu and February in Pasir Panjang. However, this rapid declining state of CI in *P. viridis* was an indication of its spawning period, when their gametes were released in the water column. These findings would help in the development of captive breeding techniques and mass seed production in aquaculture.

Key words

Mussel, *Perna viridis*, Condition Index, Spawning

Introduction

The green-lipped mussel, *Perna viridis* is widely distributed throughout the Indo-Pacific region and is extensively cultured in Asia (Rajagopal *et al.*, 1998; Kripa and Mohamed, 2008; Laxmilatha *et al.*, 2011) as a cheap animal protein source because of its fast growth and natural abundance (Wang *et al.*, 2011). It also occurs broadly in shallow waters along the west coast of Peninsular Malaysia (Ismail *et al.*, 2000; Yap *et al.*, 2002; Al-Barwani *et al.*, 2007). In Malaysia, *P. viridis* has been considered until recently as an unimportant fishery product, except in the coastal areas from where it was locally collected for food (Mazuki, 1998). In 1977, the Fisheries Research Institute of Malaysia initiated an experimental culture of *P. viridis* in Penang (Mazuki, 1998). Since then, the culture of *P. viridis* has further developed and in 1994, more than 123 farmers produced some 969 tonnes of whole shelled mussel (Mazuki, 1998).

Spawning is initiated by either sex of the green mussel with each releasing two streams of gametes into the water (Stephen and Shetty, 1981). Spawning has also been induced by the presence of other spawning individuals in the area and/or drops in salinity (Stephen and Shetty, 1981). According to Sivalingam (1977), spawning is closely related to the
monsoon seasons and usually occurs twice a year during March-April and October-November. It is most prevalent during southwest monsoon rainfall (Sivalingam, 1977). However, green mussels located in the Johore Straits, Malaysia (Tham et al., 1973; Choo, 1974) and Quezon Province, Philippines (Walter, 1982) exhibit continuous breeding throughout the year. Al-Barwani et al. (2007) observed a major spawning event of *P. viridis* in the month of January and February, while studying the population dynamics of this species at Malacca, Malaysia. In Peninsular Malaysia, the natural spat fall areas for *P. viridis* are confined to the west coast, mainly in Johore and Malacca (Mazuki, 1998).

*P. viridis* is commercially important due to its rapid growth rate and high population densities (Rajagopal et al., 1998). The green mussel is also a good candidate for cultivation because reproduction can be induced throughout the entire year (Sivalingam, 1977; Coeroli et al., 1984). The mussel can also be transplanted from one environment to another with little adverse effects (Parulekar et al., 1982).

Meat yields of mussels (soft tissue weight or volume) are known to undergo obvious seasonal changes, which have been related to cycles in the storage and consumption of energy reserves, and the development and release of gametes (Lutz, 1980). Information generated from the calculation of meat yields is of interest for both the scientific community and the commercial fishery industry. The later uses the information for marketing process, since it is of their interest to sell mussels when it is at maximum weight. Many different methods exist for measuring meat yields or better production termed Condition Index (CI) (Vakily, 1989). It is a commonly used index that is based on dry flesh weight as a proportion to the shell volume (Seed and Suchanek, 1992). CI in mussels varies according to body size, season, level of parasitic infection and with local environmental conditions, especially with regards to food availability and degree of aerial exposure (Seed and Suchanek, 1992). The objective of the present study was to investigate the exact spawning period based on the estimated CI of *P. viridis* in the coastal waters of Peninsular Malaysia.

**Materials and Methods**

**Sampling, biometrics and hydrographic measurements:** Monthly samples of *P. viridis* were collected from September, 2003 to February, 2004 from culture rafts at Sebatu in Melaka (02º26.002'N; 102º28.004'E) and at Pasir Panjang in Negri Sembilan (02º25.243'N; 101º55.542'E). Thirty mussels within a size range of 70-80 mm were used for dry weight measurements. Mussels were kept in a freezer until analysis. Prior to analysis, the mussels were cleaned from all the encrusting organisms and their byssus was removed. Biometric measurements such as length (maximum length along the anterioposterior axis), height (maximum length along the dorsoventral axis) and width (maximum length through both valves) of each individual were measured using a vernier caliper to the nearest 0.1 mm. The total weight of each individual was then recorded on an electronic balance. They were then dissected carefully and the wet soft-tissue weight and the shell weight were measured to the nearest 0.01 g. Dry tissue weight was measured after drying them individually for at least 72 hrs at 105 ºC to constant weight. The physical-chemical parameters measured at the time of sampling included temperature, salinity, dissolved oxygen (DO), pH and specific conductivity (SpC), using a Hydrolab multi-probe meter. For measuring the suspended particulate matter (SPM), water samples were immediately filtered upon reaching the lab oratory; 500 ml of water sample was filtered through a pre-weighted Whatman GF/C glass-fiber filter (Park et al., 2001). Chlorophylla concentration was determined on acetone extracts using fluorometric method as modified by Parsons et al. (1984) with 10 AU Fluorometer (Turner Designs).

**Condition index (CI):** In literature, different methods measuring CI depending on the purpose behind obtaining the index. A simple method related to wet meat weight to the whole (live) weight is common in mussel farming practices (Vakily, 1989). In biological studies, a more complex one is performed in which the index is determined relating the total soft tissue dry weight to shell volume (shell length × height × width) (Parsons et al., 1984). In the present study, the condition index (CI) of each single mussel from both the sampling sites was calculated, by the formula given below (Yap et al., 2003):

\[
CI \left( \text{g cm}^{-3} \right) = \frac{\text{Total soft tissue dry weight (g)}}{\text{Shell volume (cm}^3\text{)}} \times 1000
\]

**Statistical analysis:** The data obtained from the present study were analyzed using the Computerized Statistical Package for Social Science (SPSS) version 11.5. Independent sample's t-test was used to compare the means of CI between the two sampling sites. Analysis of variance (ANOVA) was used to compare the CI of different months. Normality of data was checked by Kolmogorov-Smirnov's (n>50) or Shapiro-Wilk's (n<50) test, Histograms, Box plots and Normal Q-Q plots.

**Results and Discussion**

A total of 180 and 176 samples of *P. viridis* were examined from Sebatu and Pasir Panjang, respectively. The mean shell length of *P. viridis* during six month study were 74.75 ± 3.57
Comparison of condition index in the green-lipped mussel

Table 1: Monthly readings of temperature, salinity, dissolved oxygen (DO), pH, specific conductivity (SpC) and suspended particulate matter (SPM) at Sebatu, Peninsular Malaysia

<table>
<thead>
<tr>
<th>Months</th>
<th>Temp (°C)</th>
<th>DO (mg l⁻¹)</th>
<th>pH</th>
<th>Salinity (ppt)</th>
<th>SpC (μS cm⁻¹)</th>
<th>SPM (mg l⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sept, 03</td>
<td>29.99</td>
<td>6.71</td>
<td>7.32</td>
<td>28.53</td>
<td>43.67</td>
<td>51.70</td>
</tr>
<tr>
<td>Oct, 03</td>
<td>29.28</td>
<td>5.99</td>
<td>7.45</td>
<td>30.11</td>
<td>46.30</td>
<td>49.66</td>
</tr>
<tr>
<td>Nov, 03</td>
<td>29.94</td>
<td>6.10</td>
<td>8.49</td>
<td>27.93</td>
<td>43.30</td>
<td>44.10</td>
</tr>
<tr>
<td>Dec, 03</td>
<td>27.94</td>
<td>6.00</td>
<td>8.01</td>
<td>29.62</td>
<td>45.63</td>
<td>31.95</td>
</tr>
<tr>
<td>Jan, 04</td>
<td>28.04</td>
<td>6.12</td>
<td>7.88</td>
<td>31.46</td>
<td>47.88</td>
<td>57.65</td>
</tr>
<tr>
<td>Feb, 04</td>
<td>27.82</td>
<td>7.61</td>
<td>8.12</td>
<td>33.26</td>
<td>50.75</td>
<td>51.30</td>
</tr>
</tbody>
</table>

Table 2: Monthly readings of temperature, salinity, dissolved oxygen (DO), pH, specific conductivity (SpC) and suspended particulate matter (SPM) at Pasir Panjang, Peninsular Malaysia

<table>
<thead>
<tr>
<th>Months</th>
<th>Temp (°C)</th>
<th>DO (mg l⁻¹)</th>
<th>pH</th>
<th>Salinity (ppt)</th>
<th>SpC (μS cm⁻¹)</th>
<th>SPM (mg l⁻¹)</th>
</tr>
</thead>
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<td>Sep, 03</td>
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<td>29.79</td>
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<td>7.37</td>
<td>31.30</td>
<td>47.89</td>
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<tr>
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<td>8.50</td>
<td>28.10</td>
<td>43.55</td>
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</tr>
<tr>
<td>Dec, 03</td>
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<td>5.54</td>
<td>7.97</td>
<td>30.96</td>
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<td>70.60</td>
</tr>
<tr>
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<td>6.79</td>
<td>7.88</td>
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<td>47.26</td>
<td>89.65</td>
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</tr>
</tbody>
</table>

Fig. 1: Temporal variations in Condition Index of P. viridis at Sebatu and Pasir Panjang

mm (SD) and 77.13 ± 5.82 mm (SD) at Sebatu and Pasir Panjang, respectively.

Temporal variations in the CI of P. viridis at Sebatu and Pasir Panjang are presented in Fig. 1. The CI values at Pasir Panjang population (15.18-19.41 g cm⁻³) were nearly within those (10.15-20.92 g cm⁻³) reported from Peninsular Malaysia (Yap and Al-Barwani, 2012), however the values were lower than those (21.06 - 27.18 g cm⁻³) found from the Sebatu population. The CI at Sebatu was always found to be higher than in the Pasir Panjang population regardless of the higher shell length from that in Pasir Panjang (Yap et al., 2003).

The index varied throughout the study at two sites in a relatively different pattern. The pattern showed high indexes in the first three months and a drop in the month of December in Pasir Panjang (P < 0.036). The CI values in Sebatu were low in the first two months then increased significantly in November (P < 0.001). In December and January, the CI values continued to decrease significantly (P < 0.001) until it reached a minimum level (21.06 g cm⁻³) in the month of January. While in Pasir Panjang, the index significantly increased (P < 0.001) again in January and dropped back to low levels in February. The increase in CI in January could be a result of sudden increase in food availability, which was obvious from the chlorophyll a concentrations in Pasir Panjang (Fig. 2). A drop in CI at the both sites in December is believed to be a result of release of gametes for spawning (Lutz, 1980; Vakily, 1989; Seed and Suchanek, 1992). This is also confirmed with the data from salinity readings (Tables 1 and 2), which in both sites were lower during the month of November and December than in October. This drop in salinity could be the cause that induced spawning in P. viridis at both the sites and thus dropped the CI values.

Fig. 2: Temporal variations in Chlorophyll a g µ l⁻¹ at Sebatu and Pasir Panjang
A correlation test was performed between the estimated CI values of P. viridis and different physical-chemical parameters, however, no significant correlation was recognized among them.

A comparison of CI between the two sites was performed using Independent Samples t-test. The test showed significant by (P < 0.001) high CI levels at Sebatu than at Pasir Panjang. This could be due to the fact that P. viridis in Sebatu was cultured within its natural spat fall areas as reported by Mazuki (1998), and the environmental condition was more favorable over there.

The present study represents a first successful investigation on the Condition Index of the green-lipped mussel P. viridis at Sebatu, and Pasir Panjang, Peninsular Malaysia. The findings emerged from the present study would immensely be helpful in understanding the exact precision on the spawning period, which will eventually assist in the development of captive breeding and mass seed production of this important mussel for commercial aquaculture.

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References


