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Analysis of Condition Index in *Polymesoda expansa* (Mousson 1849)

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Abstract: The Condition Index (CI) is a method to measure overall health of fish and that has been applied to estimate the effect that different environmental factors have on clam meat quality. The CI of local mangrove clam *Polymesoda expansa* in Kelulit, Miri Sarawak was determined from October 2010 to November 2011. Condition index that is generally used to characterize the physiological activity of organisms, varied from 1.8% in December 2010 to 3.4% in October 2011, with low values observed during the spawning period. The clam attained their best condition in quality of flesh weight during July-October. In present study, the CI showed a clear relationship with the reproductive cycle of *P. expansa*. However, no significant correlation ($p>0.05$) was found between CI and the different physicochemical parameter of seawater. The data presented is necessary for developing sustainable management strategies and broodstock selection for the species which is crucial in aquaculture development.

Key words: Condition index, fish production, chlorophyll a, *Polymesoda expansa*, Sarawak

INTRODUCTION

The mud clam *Polymesoda* spp. from the family Corbiculidae, is a typical mangrove bivalve which lives semi-infaunally on the soft sediment that accumulates around the roots of the mangrove trees (Ingole *et al*., 2002). The mangrove clam *P. expansa* (Mousson, 1849) is a deep burrowing bivalve found mostly in the tidal flat of Southeast Asia (Morton, 1976). Three species of *Polymesoda* spp. has been reported from the Indo-Pacific region; *P. erosa*, *P. expansa* and *P. bengalensis* (Ingole *et al*., 1994). Due to their high protein content and delicacy, mud clam is an important commodity in artisanal fishery which is the main activity in many islands of tropical and sub-tropical regions (Meehan, 1982).

Reproductive cycles of marine bivalves comprise a gametogenic phase, spawning and larval development and growth. The cycle may be annual, semiannual, or continuous, depending upon the species and location (Sastry, 1979). The reproductive cycle and spawning season of bivalves can be studied both directly and indirectly (Adjei-Boateng and Wilson, 2011). The most widely used direct method has been histological preparations and the microscopic examination of histological sections of gonads (Jintamas *et al*., 2009; Al-Barwani, 2007; Sahin *et al*., 2006; Retno *et al*., 2005). Indirect methods assess changes in condition that may have a bearing on the physiological state of the bivalve.

Condition Index (CI) have been employed by a number of authors to clarify the spawning season of bivalves (Celik *et al*., 2012; Yang *et al*., 2011; Park *et al*., 2011; Clemente and Ingole, 2009). Various CI values have been used in bivalve aquaculture which mainly served two purposes. The first is on economic aspect, where the index is used to designate the quality of a marketed product and time for harvest. The second is on ecophysiological aspect, in which the index is used to characterize the apparent health or condition of a cultured stock; and to summarize the physiological activity of the animals such as reproduction, growth, mortality, parasitic infection and secretion under the given environmental conditions (Li *et al*., 2009; Mladineo *et al*., 2007; Mercado-Silva, 2005). Therefore the use of CI as an index to measure reproductive output is a common practice in the literature (Celik *et al*., 2012; Li *et al*., 2011; Al-Barwani, 2007). However, no work to date was performed to use CI as an index to measure reproductive output of *P. expansa*.

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MATERIALS AND METHODS

Study area: Monthly samples of *P. expansa* were collected from October 2010 to November 2011 at Kelulit, Miri in Sarawak (03°58.649'N, 113°44.244'E, Fig. 1). During sampling, *in situ* physicochemical properties of seawater (temperature, salinity and Dissolved Oxygen (DO)) values were measured using a WQC-24P multiparameter probe, while water samples were taken for chlorophyll a analysis which was determined by spectrophotometer (SQ-2800P) following Strickand and Parson's method (Parsons *et al*., 1984). Live samples were collected and transferred to the laboratory in cooling box for further analysis.

Condition index: Five specimens were processed monthly in the size range of 65-75 mm to determine the individual total dry weight. The length was standardized during the whole study period in order to avoid variation in CI which resulted from different sizes of samples. The shell lengths were measured to the nearest 0.1 mm with Mitutoyo digital Vernier calipers (Fig. 2). Dry tissue weight and dry shell weight were measured after drying them individually for at least 48 h at 60°C. The Condition Index (CI) was calculated according to Devenport and Chen (1987) and the values were then divided into three fatness categories:

$$CI = \frac{\text{Dry tissue weight}}{\text{Dry shell weight}} \times 100$$

where, when:
CI ≤ 2.0 (thin)
CI 2.0-4.0 (moderate)
CI ≥ 4.0 (fat)

RESULTS

Environmental parameters: Monthly variations in seawater temperature, salinity, DO and chlorophyll a concentrations are shown in Fig. 3. Water temperature ranged between 27.7 and 31.6°C with a minimum in January and a maximum in September 2011. Salinity and DO remained relatively stable throughout the year. Seasonal variations in chlorophyll a were similar to variations in temperature and reached a maximum concentration of 7.9 mg L^{-1} in October 2011. Chlorophyll a was low during rainy season.

Condition index: A total of 55 individuals of *P. expansa* samples were examined throughout the study period. The mean shell length of the total samples during the eleven months study period was 70.93±3.45 mm (SD). The month

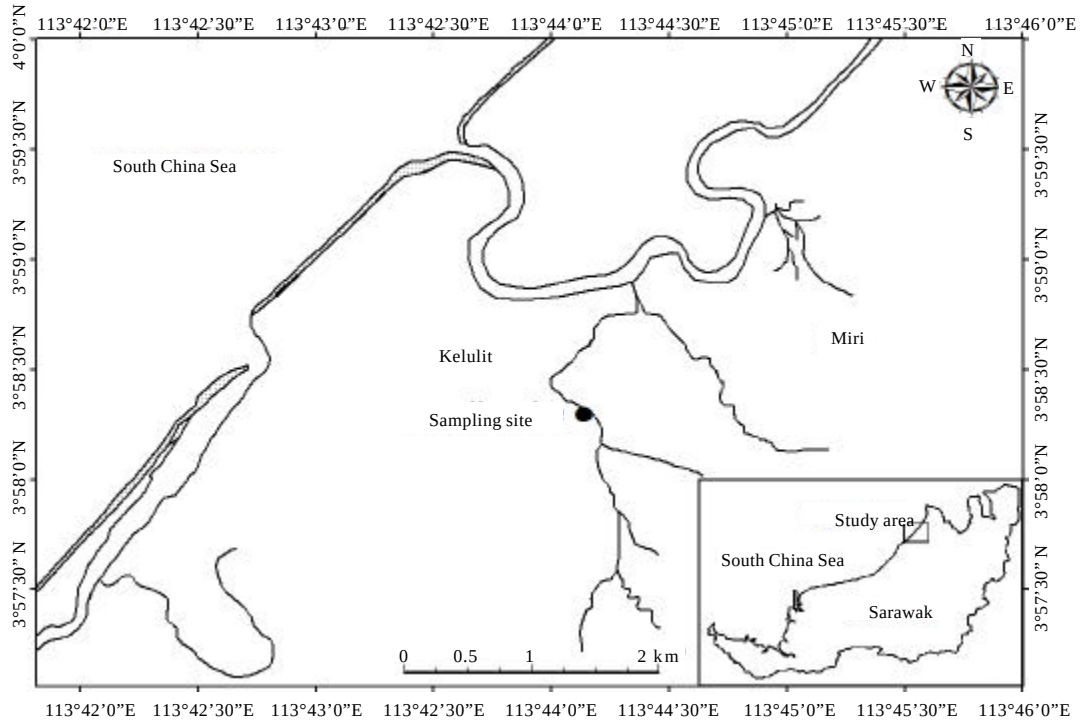

Fig. 1: Location of the sampling area where specimens of *P. expansa* were collected for this study

Fig. 2: Biometric measurement of *P. expansa* for the total shell length

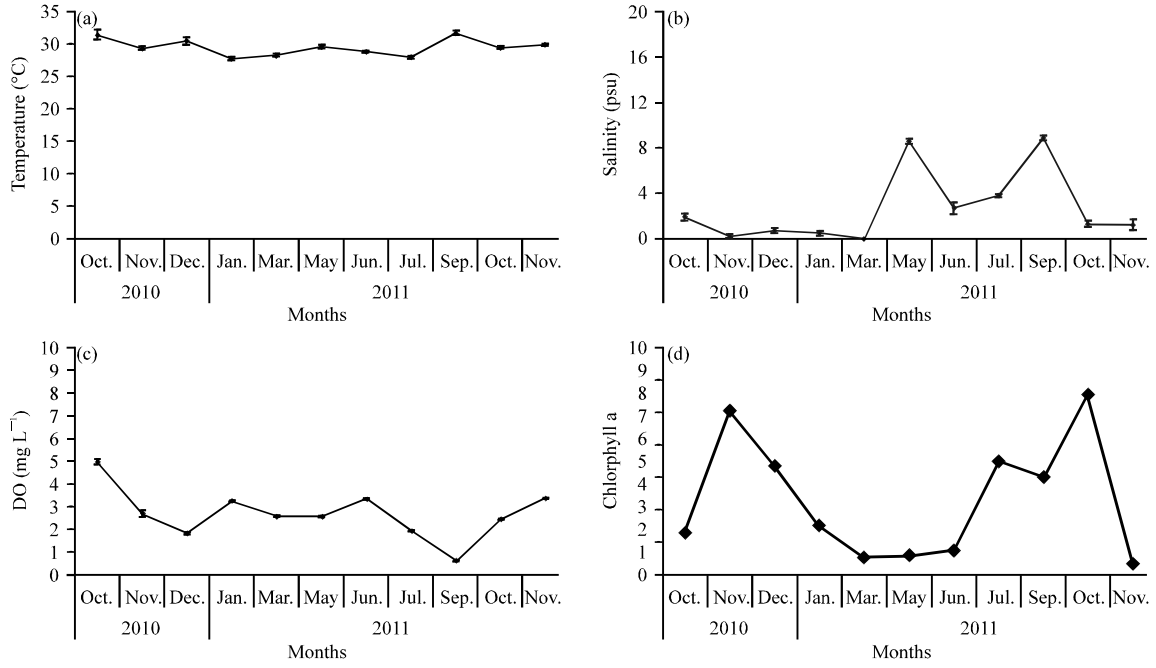

Fig. 3(a-d): Monthly variations in (a) Temperature, (b) Salinity, (c) Dissolved oxygen (DO) and (d) Chlorophyll a of the study area

of October recorded the highest overall means value of CI (2.7%) during both the 2010 and 2011 (CI = 3.4%). The months of January and July 2011 shows the same mean values of CI (2.7%) as the second highest after October 2011 while the lowest mean CI value (1.8%) was recorded during the month of December 2010 (Fig. 4). In addition, the mean values of CI with 2.5% were recorded in two months; November 2010 and March 2011. The trend of mean CI values from Kelulit showed a decreased in the last three months of 2010 and started to increase back in January 2011. As the mean values of CI were ranged from 1.8-3.4%, *P. expansa* populations in Kelulit were categorized as moderate (Table 1).

Table 1: A comparison of CI of *P. expansa* with other bivalves

Species	Range (%)	Area	References
Mytilus galloprovincialis	2.8-6.8	Sinop, South of the Black Sea	Celik *et al.* (2012)
Galatea paradoxa	2.2-7.2	Volta River Estuary, Ghana	Adjei-Boateng and Wilson (2011)
Spisula solida	5.0-10.0	Fuzeta, Algarve, Southern Portugal	Joaquim *et al.* (2008)
Anadara inaequivalvis	4.2-10.4	Southeastern Black Sea Coast	Sahin *et al.* (2006)
Polymesoda erosa	3.0-4	Mahakam Delta, East Kalimantan Province	Rizal (2010)
Polymesoda expansa	1.8-3.4	Miri, Sarawak, Malaysia	Present study

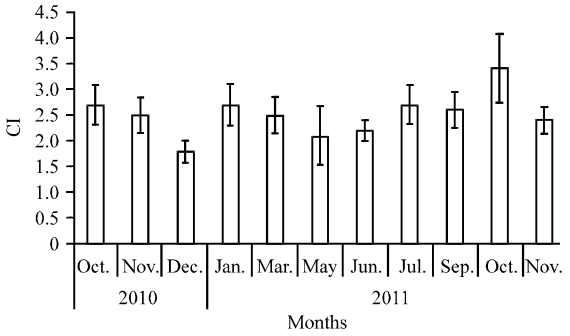

Fig. 4: Temporal variations in Condition index (CI) of *P. expansa* at Kelulit. Data presented as Mean±SD, n = 55

DISCUSSION

Environmental parameters: The use of CI in reproduction evolves since reproductive cycle of marine bivalves is regulated by an interaction of environmental and endogenous factors (Gosling, 2003). The influence of environmental conditions on bivalve reproduction was mentioned by several authors (Li *et al*., 2011; Mladineo *et al*., 2007), with the most important environmental stimuli influencing bivalve reproduction are water temperature and food availability (Ahn *et al*., 2003; Berthelin *et al*., 2000; Sastry, 1979). In addition, according to Park *et al*. (2001), the effect of temperature could be direct, affecting the metabolic rate of bivalves or indirect by affecting availability of food.

In this study, the reproductive cycle of *P. expansa* followed an annual cycle, comprising a resting stage in January-July and gametogenesis, including ripeness and spawning, during the rest of the year. The variations in the temperature were not consistent with the variations in the CI, indicating that temperature may not play an important role in determining the gonadal development and spawning of *P. expansa*. For bivalve populations that experienced similar thermal regime, gonadal growth and reproductive cycle were directly supported by the availability of food in the environment and the levels of nutrient reserves within the animals (Li *et al*., 2011; Gabbott, 1975).

The chlorophyll a, an indicator of phytoplankton biomass and a very well known source of food for bivalve mollusks, was synchronizing with the CI during the present study. Highest levels of chlorophyll a content and CI matched very well during July-October 2011. It is known that good condition values are the indicators of accumulating nutrient reserves, particularly glycogen and protein and gonadal development (Sahin *et al*., 2006; Aldrich and Crowley, 1986). A correlation test was performed between CI and the different physicochemical parameter of seawater, however, no significant ($p>0.05$) correlation was found. This is typical in a stable tropical environment where little fluctuations occur especially in seawater temperature (Walter, 1982).

Condition index: The condition index is regarded as the most sensitive to changes in the reproductive development and usually correlates well with the mean gonad index (Peharda *et al*., 2006; Ojea *et al*., 2004). Their determination was even suggested as a quick, inexpensive, representative and responsive method to assess broodstock reproductive state (Mercado-Silva, 2005; Gribben *et al*., 2004). In this study, the condition index of *P. expansa* showed a clear seasonal cycle, decreasing during spawning and recovered back when the gonad was in the resting and gametogenesis phases. There are two peaks in CI were observed during annual cycle (Fig. 4); major one in October 2011 and second one in October 2010, January and July 2011. Gradually decreasing CI from October-December 2010 and January-May 2011 indicated significant loses in tissue weight or reserves due to release of gametes (Sahin *et al*., 2006).

The present study suggests that, the spawning season of *P. expansa* at Kelulit mangroves is all year around, with major events occurring during September-December. Since the duration of the spawning period varies in a species occurring in different parts of its geographic range (Clemente and Ingole, 2009), the range of CI values for *P. expansa* in this study was relatively within the range reported in the literature with those of other bivalves (Table 1). The close correlation between condition index and gonadal development indicates that condition index is a good indicator for identifying the gonadal maturity of *P. expansa*. This could be a useful

and simple technique in the selection of broodstock for future hatchery operations as it is less expensive and time consuming compared to histological methods. In addition, it also has the advantage of being easier to teach and implement in basic shellfish enterprises (Adjei-Boateng and Wilson, 2011).

CONCLUSION

The data presented in this study provide valuable information on the timing and initiation of spawning in *P. expansa* which is necessary for developing sustainable management strategies and selection of broodstock for aquaculture use. Thus, the present study supports the use of CI as a potential indicator or reproductive cycles of *P. expansa.*

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