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# REPRODUCTIVE BIOLOGY OF THE GOBY *PSEUDAPOCRYPTES LANCEOLATUS* IN THE COASTAL MUD FLAT AREAS OF THE MEKONG DELTA

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**Abstract:** This paper describes the reproductive biological characteristics of the goby, *Pseudapocryptes lanceolatus*, in the coastal mud flat areas of the Mekong Delta. The present finding is based on the examination of 1058 specimens which was monthly collected between January 2004 and June 2005. The sex ratio of female to male was 1.00 : 0.96. Observations on the seasonal distribution of maturity stages, and variations in seasonal fluctuations in the gonadosomatic index *(GSI)*, hepatosomatic index *(HSI)* and condition factor *(CF)* confirmed that the breeding season occurred with two spawning peaks in July and October. There was marked reduction in liver size during the spawning season. Length at first maturity ($L_m$) was 15.4 cm and 16.3 cm for females and males, respectively. The batch fecundity estimates ranged from 2,652 to 29,406 hydrated oocytes per ovary in the fish ranging from 12.8 to 22.4 cm *TL*. The relationship between total length *(TL)* and batch fecundity *(F)* was $F = 0.1517*TL^{3.9757}$.

KEYWORDS: Breeding Season, Batch Fecundity, Maturity Stage, Sex Ratio

## Introduction

The goby, *Pseudapocryptes lanceolatus*, is distributed in the Indo-Pacific region and is common in the Mekong Delta (Weber and De Beaufort, 1953; Mohsin and Ambak, 1996; Rainboth, 1996). This species resides in muddy localities and also in burrows situated in mud flats of the estuarine areas (Murdy, 1989; Clayton, 1993). In the Mekong Delta, the highest number of gobiid species is found in estuarine areas (Matics, 2000), in which *P. lanceolatus* is a commercially important species for food, especially in Japan, Taiwan and Vietnam (Ip *et al.*, 1990; Dinh *et al.*, 2004). For that reason, this species is presently cultured in semi-intensive and intensive farming system; however, the seeds are collected only from the wild and not enough for aquaculture.

The Gobiidae consists mainly of small, benthic fishes that occupy estuarine habitats in tropical and subtropical waters (Chotkowski *et al.*, 1999). The estuarine habitats are ecologically

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dynamic and productive areas used by many estuarine-dependent species for reproduction (Blaber *et al.*, 1995). Many of the fishes in tropical estuaries spawn and complete their life cycle within the estuarine environment (Blaber, 2000). Nearly all gobies produce demersal eggs and highly variable number of spawnings per season (Miller, 1984). Despite the fact that the gobies are the largest family of fishes, almost nothing is known of the reproduction of most species (Blaber, 2000).

The goby *P. lanceolatus* has been studied on the ecology (Das, 1933 & 1934; Cees *et al.*, 1995), food habits and feeding apparatus (Cees *et al.*, 1995), morphology (Amrendra and Singh, 1989) and length-weight relationship (Khaironizam and Rashid, 2002). However, there was only one study on reproductive biology of the goby in Gangetic Delta that was reported by Hora (1936), but the author had not given enough evidence concerning his statements. Therefore, this study was carried out to determine some aspects of the reproductive biological characteristics of *P. lanceolatus* in the coastal mud flat areas of the Mekong Delta (Fig. 1).

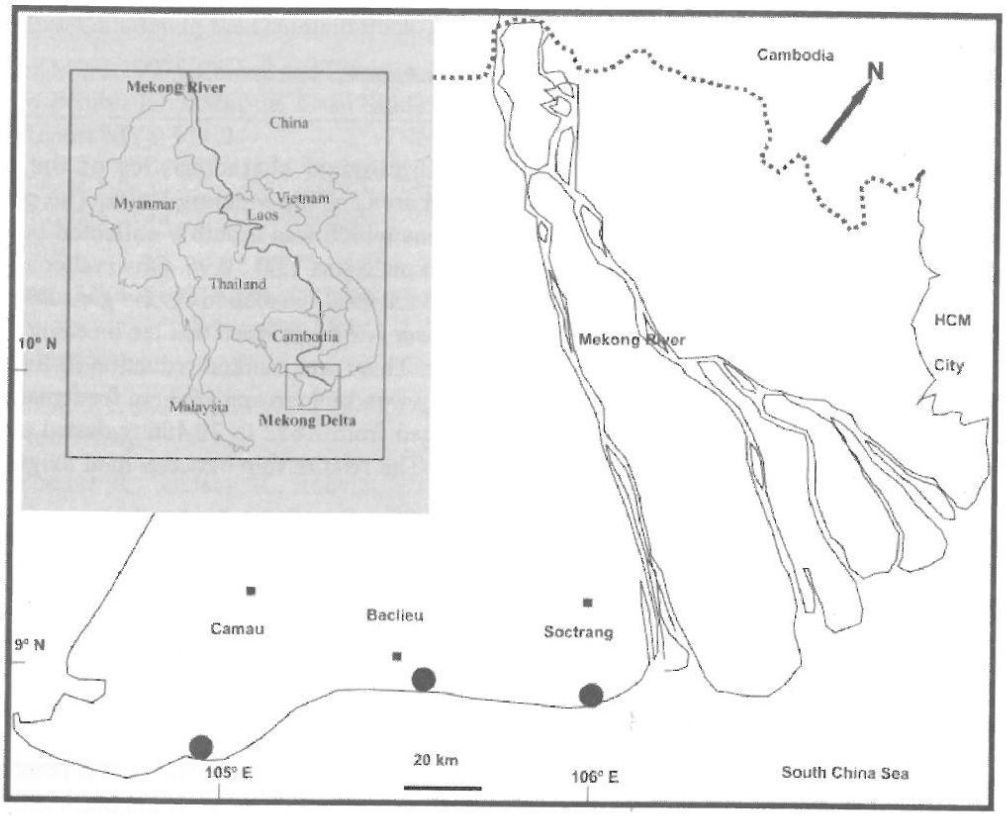


**Figure 1:** The sampling sites ( ● ) in the mud flat areas along the southeast coast of the Mekong Delta, South of Vietnam

## Materials and methods

The fish specimens were collected monthly, from January 2004 to June 2005. A total of 1058 *P. lanceolatus* specimens were measured to the nearest mm for total length (*TL*), and 0.01 g for body (*BW*), visceral (*VW*), liver (*LW*) and gonad weight (*GW*). Condition factor (*CF*) was calculated as $CF = W/W_{pred}$ (King, 1995); where $W$ is the monthly values of mean body weight and $W_{pred}$ is the

monthly predicted values of mean body weight calculated from the regression equation. The gonad development was classified into six stages according to the scale of maturity proposed by Vesey and Langford (1985) for *Gobius niger*. Gonadosomatic index (*GSI*) and hepatosomatic index (*HSI*) were determined as $GSI = [GW/(BW–VW)]*100$ and $HSI = [LW/(BW-VW)]*100$. Based on the fraction of mature specimens per length class, the maturity curve was estimated by adjusting the simple logistic model (Zar, 1999) expressed by $P = 1/\{1+\exp[-(\beta_o+\beta_1 L)]\}$; where, $P$ is the proportion of mature specimens at length class $L$, $\beta_o$ and $\beta_1$ are model parameters. Then, the length of fish at which 50% of fish attain sexual maturity (P = 0.5) was determined to be $L_m = -\beta_o/\beta_1$ for both sexes.

The whole mature ovary was placed in Gilson's fluid and periodically shaken to release oocytes from the ovarian tissue. The batch fecundity ($F$) was estimated as the number of hydrated oocytes in each ovary using the volumetric sub-sampling method (Bagenal and Braum, 1978): $F=(V/V')n$ where, $V$ is a volume of sample, $V'$ is a volume of sub-sample, and n is a number of hydrated oocytes in sub-sample. The relationship between the batch fecundity ($F$) and total length ($TL$) was described using simple standard regression. A power model was fitted to the relationship of $F$ and $TL$.

## Results

### *Sex ratio*

A total of 1058 specimens (479 females, 461 males and 118 juveniles) of *P. lanceolatus* was examined. This gave the female : male ratio of 1.00 : 0.96, which was not significantly different between females and males ($X^2 = 0.345$, $p > 0.05$). The monthly sex ratio was also determined and results indicated that the number of females was slightly higher than that of males in April-September; meanwhile, males were more than females in October-March (Fig. 2). The results showed that female *P. lanceolatus* was more than male during the raining season in the Mekong Delta (April-November).

### *Condition Factor (CF)*

The monthly values of condition factor (*CF*) were calculated for both sexes. Results show that the high *CF*-values of females were found in May and September; meanwhile those of males were determined in June. The mean condition factors were slightly higher in females than males (Fig. 3).

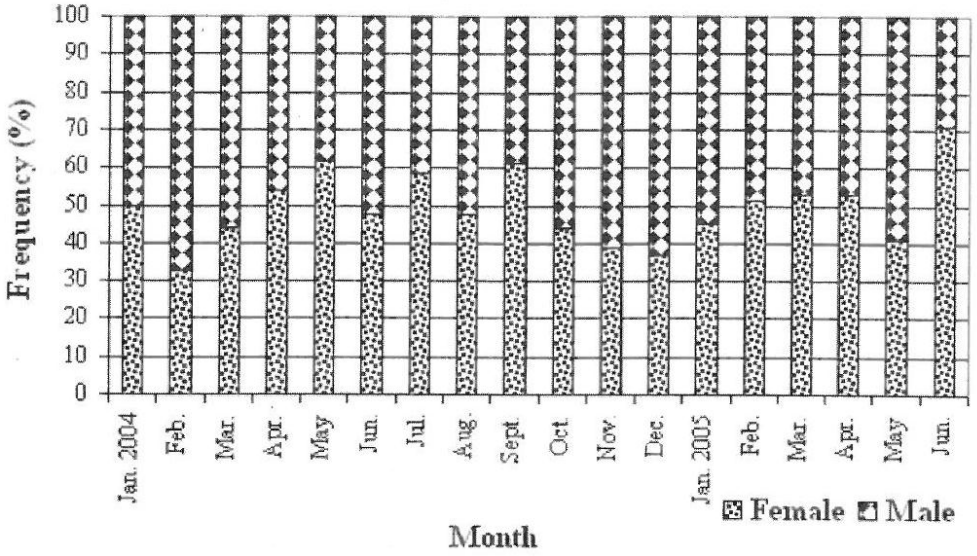


**Figure 2:** Sex ratio of goby *P. lanceolatus* in the Mekong Delta

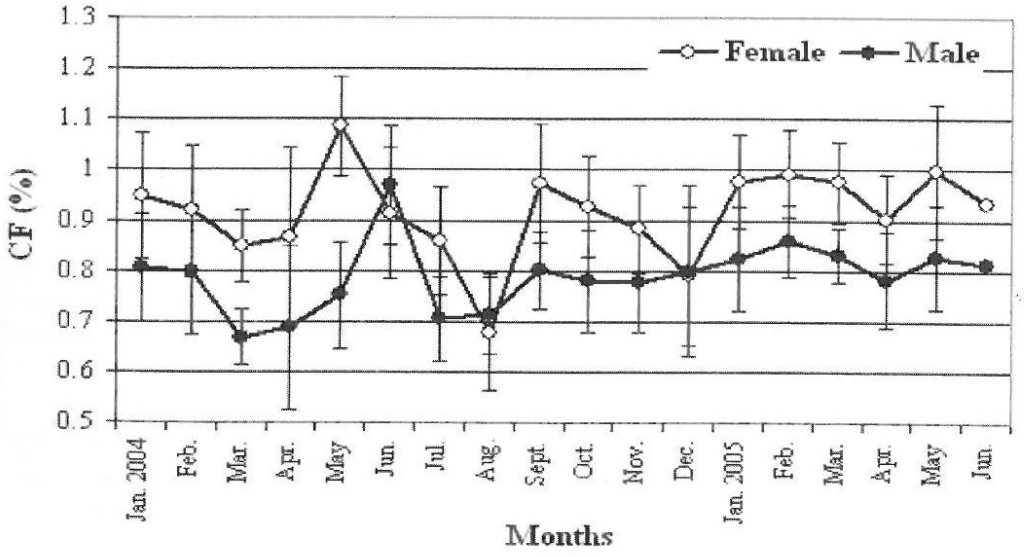


**Figure 3:** Seasonal changes in condition factor (*CF*) of female and male *P. lanceolatus*

*Sexual maturity stage and gonadosomatic index (GSI)*

Ovaries of the goby were seen to be developing (Stage II) in February, maturing (Stage III) and mature (Stage IV) in April and become dominant in June (Fig. 4). No females with running (Stage V) and spent (Stage VI) ovaries were found. Meanwhile, the maturing (Stage III) and matured (Stage IV) testes appeared in April and May, respectively. The highest percentage of mature testis was found in June (Fig. 5). Furthermore, results obtained from the monthly *GSI* values also indicated that the *GSI* of both female and male fish increased during May - December (Fig. 6). The *GSI* of females reached the highest average in July; it dropped in August-September, increased again in October, then dropped again in November-December and remained low until April. The similar pattern of *GSI* was also found in males; however, the highest values of *GSI* were determined in July and November.

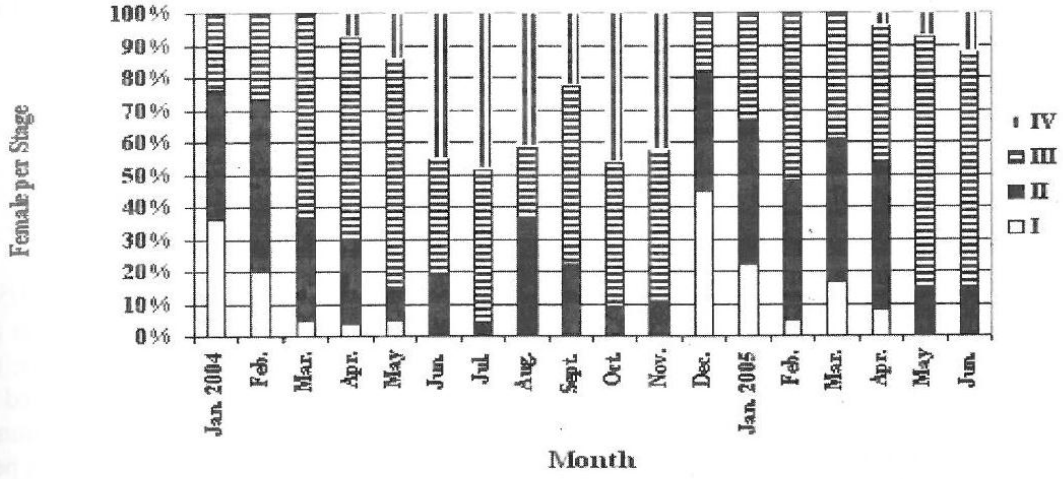


**Figure 4:** Seasonal changes in gonad stage composition of female *P. lanceolatus*

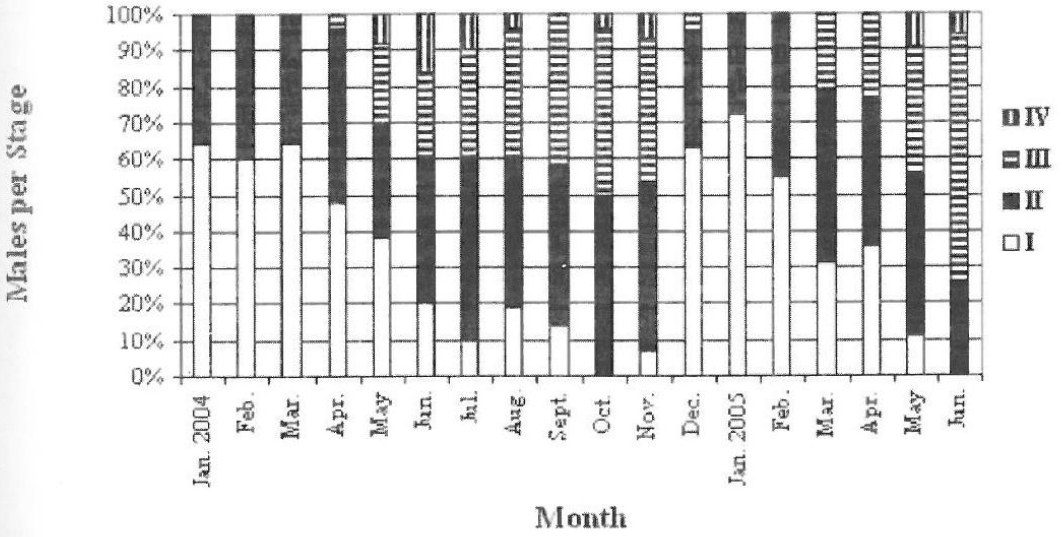


**Figure 5:** Seasonal changes in gonad stage composition of male *P. lanceolatus*

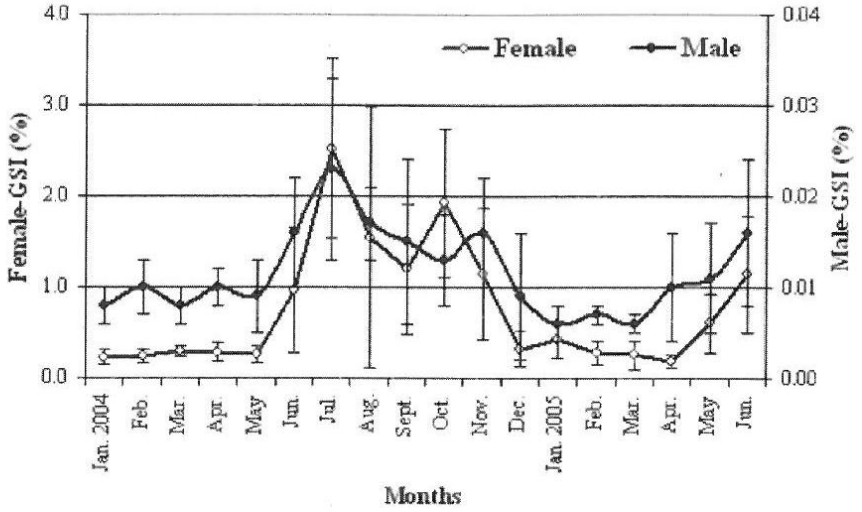


**Figure 6:** Seasonal changes in *GSI* of female and male *P. lanceolatus*

*Hepatosomatic index (HSI)*

Results showed that the *HSI* values of females were higher than that of males; however, the *HSI* of both sexes followed the same pattern (Fig. 7). *HSI* of females decreased during June-August then increased slightly in September; it decreased again and reached the lowest value in October, then increased in November. Meanwhile, *HSI* of male decreased during May-August and remained low until October, and then increased again in November. The results obtained from the fluctuations of *CF, GSI* and *HSI* showed that the breeding season of *P.* lanceolatus occur with two spawning peaks in July and October. The results also indicated that there was clear reduction in liver size during the spawning season.

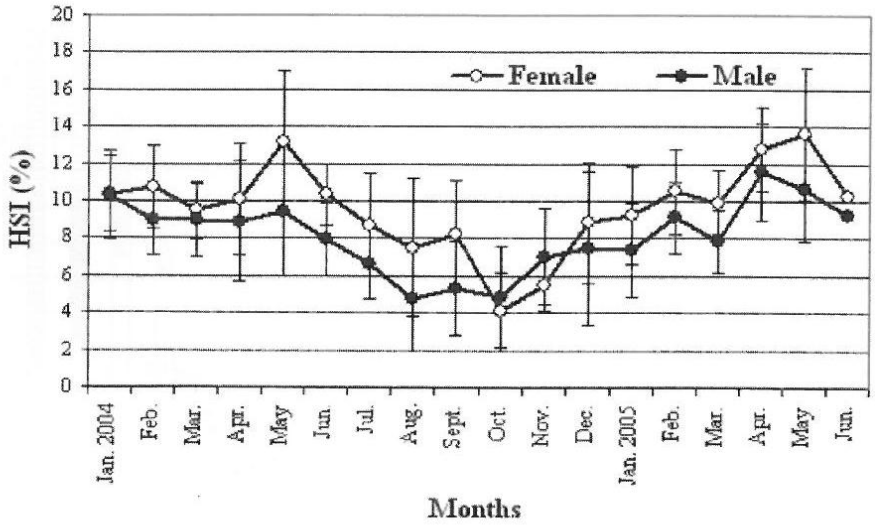


**Figure 7:** Seasonal changes in HSI of female and male *P. lanceolatus*

*Length at first maturity ($L_m$)*

For determining length at first maturity ($L_m$), the proportions of maturity for 379 female and 445 male specimens were obtained. Then, the model parameters were determined as $\beta_o$ = -125.35, $\beta_1$ = 8.14 ($p < 0.01$) for females; and $\beta_o$ = -130.05, $\beta_1$ = 7.96 ($p < 0.01$) for males. Thus, the length at first maturity ($L_m$) was obtained as 15.4 cm and 16.3 cm for females and males, respectively (Fig. 8).

*Batch fecundity (F)*

The batch fecundity estimates ranged from 2,652 to 29,406 hydrated oocytes per ovary in the fish specimens ranged from 12.8 to 22.4 cm *TL*. The mean fecundity was 15,608 (S.E. = 2,478) and the mean total length was 17.9 cm. The relationship between total length (*TL*) and batch fecundity (*F*) was $F = 0.1517*TL^{3.9757}$ ($R^2 = 0.727$; n = 48) (Fig. 9), in which *TL* in cm.

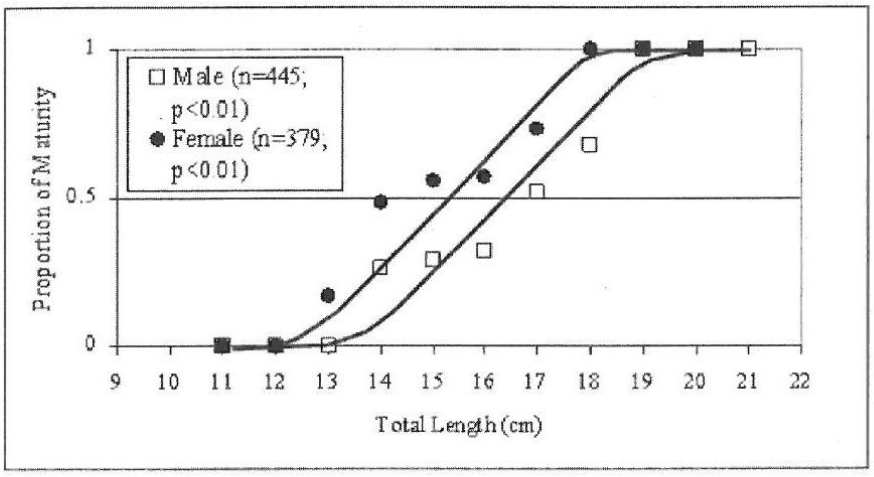


**Figure 8:** Proportion of mature *P. lanceolatus* by 1 cm total length intervals, fitted to a logistic function, $L_m$ = 15.4 cm for females and $L_m$ = 16.3 cm for males

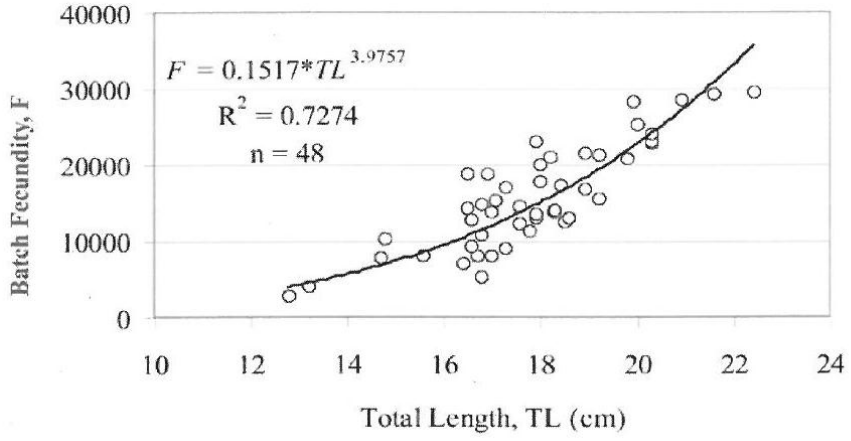


**Figure 9:** The relationship between total length (*TL*) and batch fecundity (*F*) of *P. lanceolatus*

## Discussion

Mekong River is one of the largest river in the Southeast Asia; great volumes of sediment are carried towards the coastal areas of the Mekong Delta in rainy season. Therefore, the estuarine ecosystem provides a habitat for a variety of wildlife species, as well as spawning grounds for fish (Nedeco, 1993). In the present study, the high *GSI* values of the goby were determined from June to November in both sexes. In addition, the *HSI* values also decreased during June-August and October. For gobies, Miller (1984) stated that the liver has been shown to play the leading role during the annual breeding season. The decrease in liver weight during pre-spawning probably results from the passage of materials from the liver to the gonads. Hence, the results indicated that the breeding season of the goby occurred between June and November, nearly during the rainy season (April - November) in the Mekong Delta, with two spawning peaks in July and October. This finding also agreed with the recruitment pattern which showed two recruitment peaks with an interval about 5 months.

In the present study, the GSI values of female were higher than those of male, which probably contributes towards the heavier mature females when compared to mature males. This finding agrees with that of Kader *et al.* (1988) study on reproductive biology of *Gobioides rubicundus*. The authors showed that the *GSI* values of females in mature stages ranged from 1.031 to 2.8879 which were also higher than those of males (ranged from 0.01 to 0.0482). They also revealed that the spawning periods of the male was extended from late January to early February and from late June to early October while those of the female extended from late January to early February and from late August to early September. Those results also indicated that *Gobioides rubicundus* spawns two times per year. Furthermore, no females with running and spent ovaries were found in the specimens of the present study. According to Masato *et al.* (1993), maturation of following the migratory nucleus stage is likely to proceed in the spawning nets; therefore, such specimens could not be collected for their study.

In the Gangetic Delta, *P. lanceolatus* breeds just before the beginning of the southwest monsoon during the rainy season, i.e., from July to September (Hora, 1936). Miller (1984) and Blaber (2000) also stated that nearly all gobies are multiple-spawners; they breed for all or most of the year, often a wet season. In goby *Aphia minuta*, the breeding season is quite long and that spawning takes place at least twice during its short lifespan (Caputo *et al.*, 2003). *Acentrogobius masago* (Tomiyama) spawn on sandy mud bottoms near Kyushu from May to September; meanwhile, *Acentrogobius reichei* (Bleeker) spawns before the monsoon season, in October and November (Charles and Donn, 1966). During the breeding season, *Gobius minutus* can spawn at least three batches of eggs (Healey, 1971). Ha and Kinzie (1996) revealed that the fecundity of gobiids varies widely among and within species, ranging from less than 100 eggs in *Eviota lacrimae* to over 500,000 eggs in *Awaous guamensis*.

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