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# The effect of depth variation on size and catch rate of green tiger shrimp, *Penaeus semisulcatus* (De Haan, 1884) in Bushehr coastal waters, Northern Persian Gulf

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**Catch data of *Penaeus semisulcatus* were collected for three years (2009-2011) during the period of June to August to estimate the effect of depth variation on length frequency and catch rate (Kg $h^{-1}$) of the species. No difference was observed between the shallow and deeper catch rate (ANOVA test, $P > 0.05$). However, the size composition of green tiger shrimp were affected by depth variation (Kolmogorov-Smirnov test, $P < 0.05$) and were positively correlated with depth ($P < 0.05$ and $r = 0.140$). The smaller individuals prefer shallow waters, indicating behaviour differences between the juveniles and adults of this species. The positive correlation between size of shrimp and water depth can be attributed to the behaviour predation.**

**Key words:** Green tiger shrimp, *Penaeus semisulcatus*, catch rate, depth variation, Persian Gulf.

## INTRODUCTION

Penaeid shrimps are found throughout the tropical and subtropical regions and include 14 genera and 110 species (Holthuis, 1980). Some species spend their entire life time in the sea water and some others inhabit the estuaries, but numerous species use both conditions for a certain time. World catch of shrimp is made up of a combination of eight genera (*Metapenaeus*, *Parapenaeus*, *Parapeneopsis*, *Metapeneopsis*, *Penaeus*, *Trachypenaeus*, *Xiphopenaeus* and *Artemisia*) (Garcia, 1988).

The Persian Gulf is lying between 24° to 30° N and 49° to 61° 25' E. Persian Gulf is an eutrophic sea with average depth of 36 m, which allow the entire water column to be well mixed (Reynolds, 1993). The fishing industry in the Persian Gulf has been important since archaic times and commercial shrimp fishing first began in earlier 1960s in the Iranian waters (Boerema, 1969).

During these times, fishing was limited to the Bushehr waters and was based on green tiger shrimp (*Penaeus semisulcatus* De Haan, 1884) (Niamaimandi et al., 2007). Presently, bottom trawling has been banned in Iranian waters of the Persian Gulf except shrimp fishing seasons. Opening fishing season is based on pre-season cruises that appraise the abundance and carapace length (CL) of shrimp, also time of closure is based on the catch per unit effort (CPUE) index so that when it indicates that 20% of the shrimp stock remains, shrimp fishing season will restrict.

Although, Iran has longer coastline with the Persian Gulf, information about shrimp catch and biological charac-

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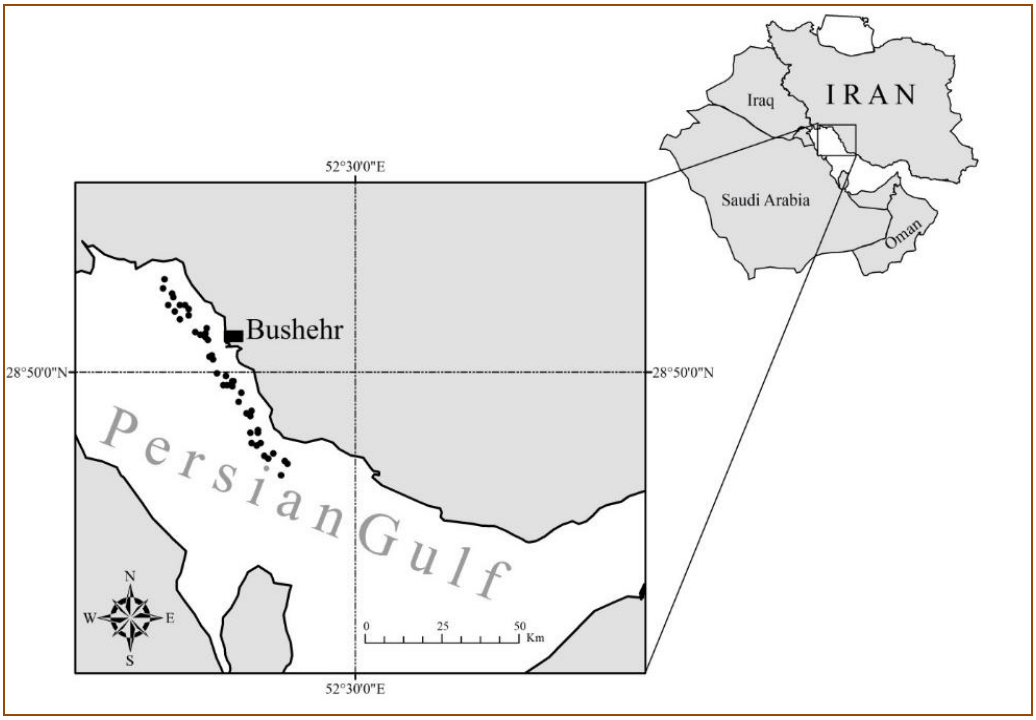


**Figure 1.** Map of the Persian Gulf and location of sampling sites for *P. semisulcatus* in Bushehr waters (2009-2011).

**Table 1.** The number of hauls and individuals in three depths strata of Bushehr coastal waters.

| Depth (m) | Haul | Measured individual |
|---|---|---|
| < 10 | 33 | 8022 |
| 10-20 | 33 | 10673 |
| 20-30 | 28 | 4523 |
| Total | 94 | 23218 |

characteristics of Penaeid shrimps is little in Iranian waters (Paighambari et al., 2003; Valinassab et al., 2006; Paighambari and Daliri, 2012). Subsequently, the main objectives of this study were to investigate the impact of depth on catch rate of shrimp, survey the relationship between shrimp length and depth and to provide baseline information required for fisheries management.

## MATERIALS AND METHODS

### Study area, sampling collection and sampling stations

The study area extended from longitude 50° 6' to 52° 58' E and latitude 27° 14' to 30° 16' N (Bushehr coastal waters) and covers the fishing grounds of shrimp (Figure 1). The Stratified Random Sampling was conducted by R/Vs SHANAK and GULF for three years (June-August of 2009 to 2011). The used sampling gears were bottom trawl nets with a 31 m head line and a 40 and 50 mm mesh size (stretched mesh) in the cod-end and body, respectively. Towing was averagely carried out between 1 to 2 h at speeds of about three knots and depth was measured by a vertical FCV-667 echo-sounder. For each tow data of trawl duration and speed, fishing depth, catch weight and global position system (GPS) were recorded on board. After each haul, the total catches were unloaded on the deck and by-catch was separated from shrimp. Shrimp species were identified to the lowest taxonomic level (Carpenter et al., 1997) and weighed. The total length (TL) of 23,218 individuals of green tiger shrimp were measured (from the tip of rostrum to the tip of the telson) during 94 hauls (Table 1).

### Analysis of catch

Data analyses were done by Statistical Package for the Social Sciences (SPSS) 19 software. The catch per hour (Kg $h^{-1}$) was estimated for all hauls, and the arithmetic mean of the catch rate was calculated for each stratum (depth: < 10 m, 10 to 20 m and 20 to 30 m). Kolmogorov-Smirnov and Levene tests were used to analyze normality of the data and homogeneity of variances (Zar, 1999). Kolmogorov-Smirnov tests were also used to determine whether the size composition of individual significantly differed between three depths strata. Correlation between size of shrimp and depth was examined using 'Eta squared' correlation coefficient ($\eta^2$).

## RESULTS

### Catch rate

Figure 2 indicates the catch rates of green tiger shrimp between three stratums during 94 hauls. The one-way

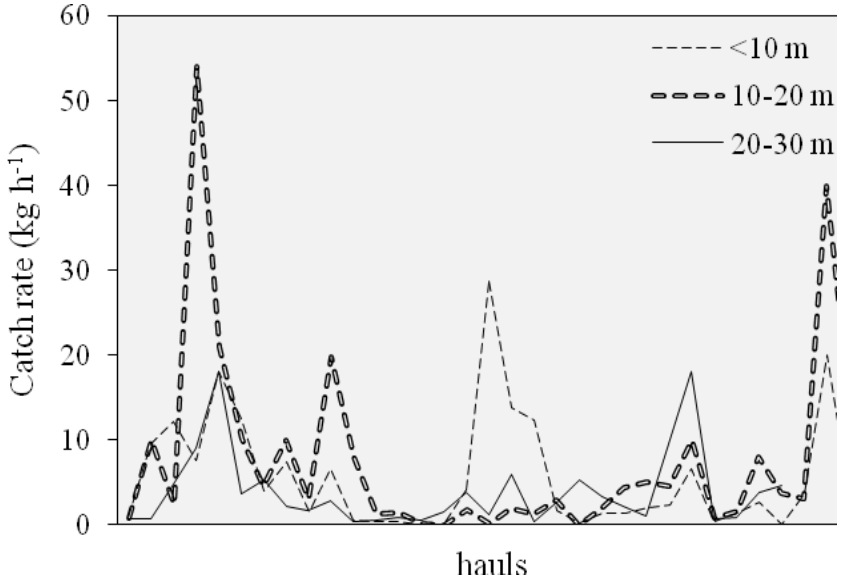


**Figure 2.** The catch rates (Kg $h^{-1}$) for all hauls conducted between three depth strata of Bushehr coastal waters (N Persian Gulf).

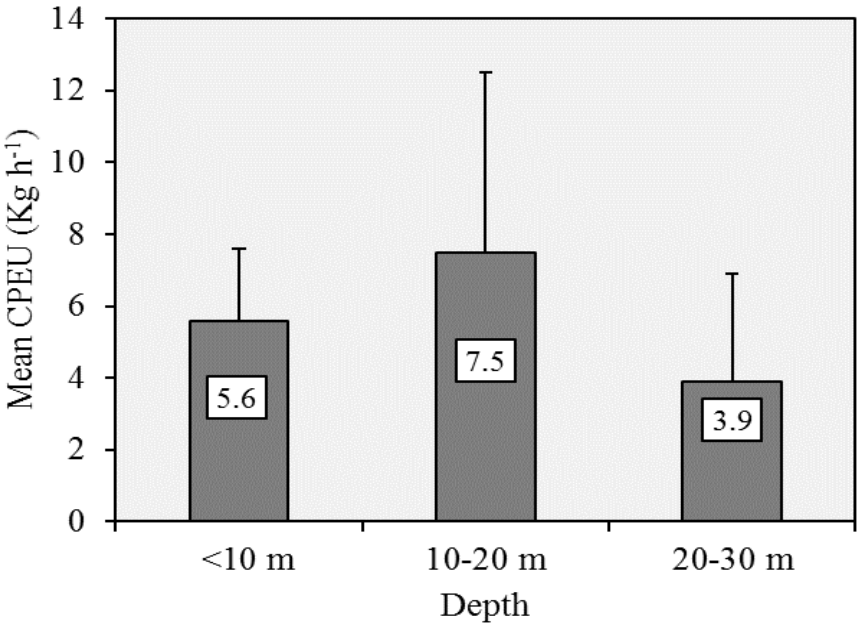


**Figure 3.** Mean catch rate (Kg $h^{-1}$) (±SD) of *P. semisulcatus* in three depth strata of Bushehr waters (2009-2011).

analysis of variance (ANOVA) was used to investigate whether the catch rates differed among the three stratums and showed not significant differences (5% level) between them (F = 0.732, P = 0.484, Figure 3). Duncan's test was used for a posteriori comparison among means of different depths (Zar, 1999).

**Size composition and correlation between length and depth**

Length frequency distribution of the green tiger shrimp in three depth strata (*i*: < 10 m, *ii*: 10 to 20 m and *iii*: 20 to 30 m) is shown in Figure 4. The size composition of

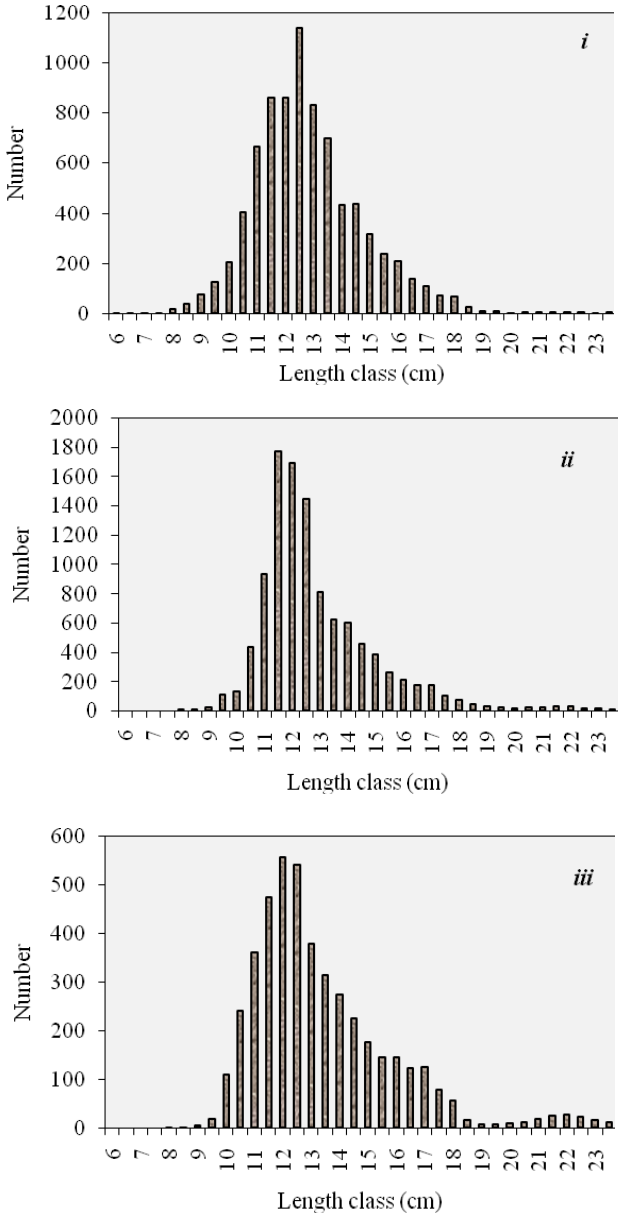


**Figure 4.** Length frequency distribution of the green tiger shrimp (P. semisulcatus) in three depth strata during June-August of 2009 to 2011 (i: < 10 m, ii: 10-20 m and iii: 20-30 m).

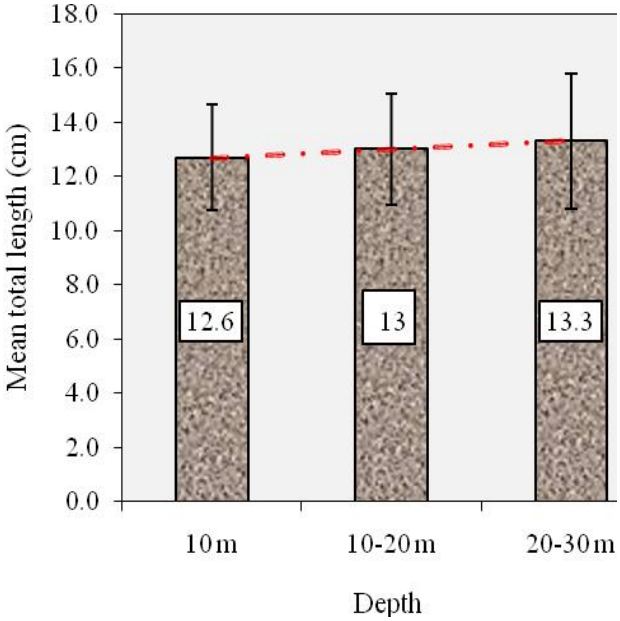


**Figure 5.** Mean length (± SD) of green tiger shrimp in three depth strata of Bushehr coastal waters (N Persian Gulf). The red liner shows the slightly positive correlation between size of shrimp and depth.

shrimp differed significantly between three depth strata (*i* and *ii*: $D_{Ks}$ = 4.912, P = 0.001; *i* and *iii*: $D_{Ks}$ = 4.057, P = 0.001; *ii* and *iii*: $D_{Ks}$ = 5.834, P = 0.001). The size of green tiger shrimp was positively correlated with depth (P < 0.05 and *r* = 0.140) (Figure 5).

## DISCUSSION

Our results indicate that the catch rates were not affected by depth, whilst depth variation is an important determinant of the size composition of shrimp. In our study it was assumed that catch rates of *P. semisulcatus* reflects their abundance. We can cite likely two reasons for lack of relationship between catch rates of green tiger shrimp and depth of study area: (a) Penaeid shrimps mostly inhabited in mud substrates (Somers, 1987) and northern side of the Persian Gulf dominated by soft sediments (Figure 6) and (b) since the waters of the Persian Gulf lie in the photic zone, sea floor content largely biogenic nutrient (Sheppard, 1993). Thus, feeding habits is not likely an important criterion in the distribution of shrimps in the different depths of the Persian Gulf, but no certain information is available on this aspect at present. Based on the fact that trawling was carried out in day time, comparison of catch rate between day and night were not considered.

Analysis of size composition showed positive correlation between size of shrimp and depth, which is in agreement with reports of Parker (1970) and Bishop and Khan (1991). Also, Macpherson and Duarte (1991), Sinclair (1992), Swain (1993) and Petrakis et al. (2001) reported a positive correlation between size of demersal fish and depth. According to Garcia (1988), the maturity lengths of Penaeid shrimps (total length) usually fall between 8 and 10 cm. Our study demonstrated that the juvenile individual occupies the shallower waters (Figure 7).

The difference between the shrimp size composition of between shallow and deeper water indicates that the bathymetrical distribution of the species is size. The bigger individuals prefer deeper waters. Predation rates

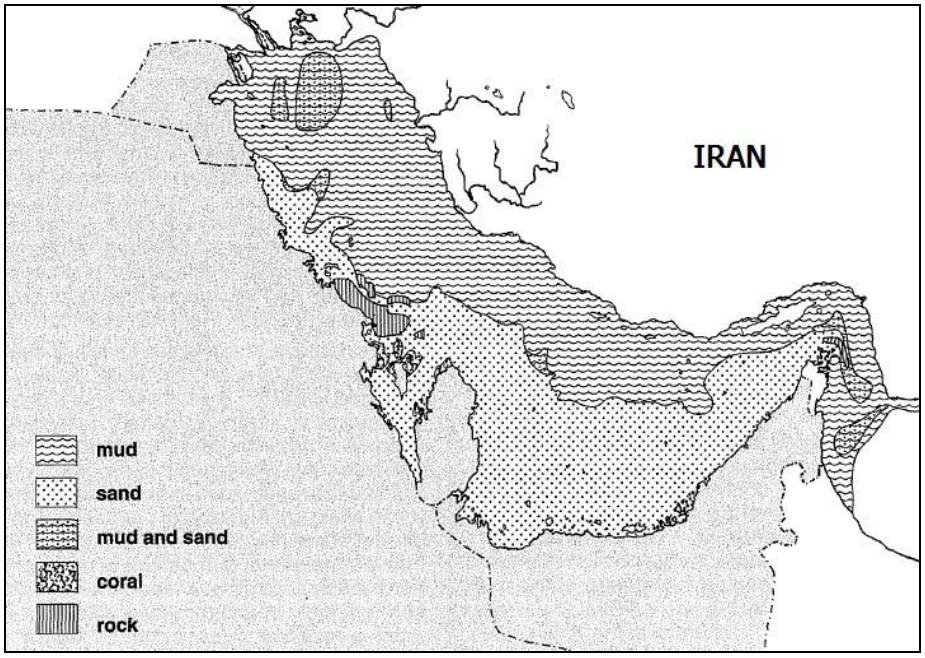


**Figure 6.** Bottom type of the Persian Gulf (Emery, 1956; Kuronuma and Abe, 1972; Carpenter et al., 1997).

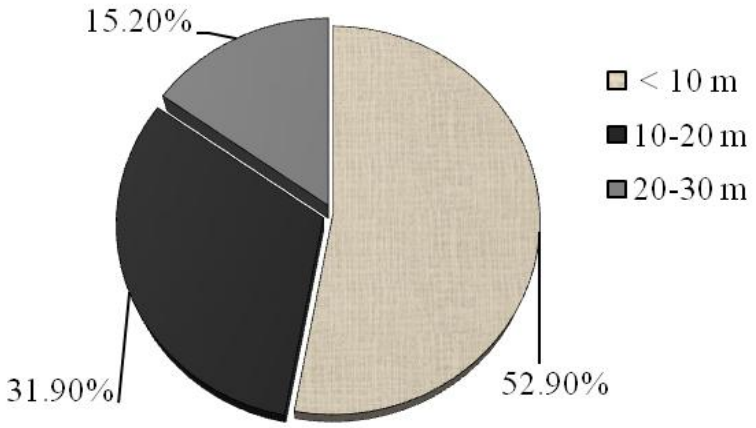


**Figure 7.** Percentage of juvenile shrimps caught between three depth strata of Bushehr coastal waters (N Persian Gulf).

on juvenile and smaller shrimps are affected by type of habitat and fish predation is higher on uncover sea floor than in dense vegetation (Zimmerman and Minello, 1984; Minello et al., 1989 and Loneragan et al., 1994). Sea-grass mostly occurs in shallow waters (Short and Coles, 2001) and acts as a nursery ground for shrimp and fish (Tom et al., 1984). In this study, positive correlation between size of shrimp and depth may be attributed to avoidance of predation. Shallow waters protect juvenile and smaller shrimps from predation by impeding access of fish and larger individuals (Penn, 1981). Also, Bishop and Khan (1991) suggested that water depth is an important factor affecting spatial distri-bution of juvenile Jinga shrimp (*Metapenaeus affinis*).

This is the first study on the green tiger shrimp catch from the Iranian waters of the Persian Gulf, but is not comprehensive. We suggest further study to be con-ducted annually and the data on temperature, salinity and

current for each month recorded. Also an estimate of the relationship between these factors and abundance of shrimp should be considered.

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