Some properties reproductive of the speckled shrimp (*Metapenaeus monoceros* Fabricius, 1798) in the North-eastern Mediterranean

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Received: November 2012 Accepted: December 2013

Abstract

Speckled shrimp (*Metapenaeus monoceros*), is a commercially important prawn in the embayments and estuaries of the Mediterranean Sea**.** It is originally a Lessepsian species which had migrated from the Red Sea into the Mediterranean Sea through the Suez Canal. This study was carried out in the North-eastern Mediterranean Sea between November 2009 and October 2010 with monthly sampling of speckled shrimps, by bottom trawl operations. Totally 784 specimens of this shrimp were studied, and the male/female ratio was determined as 1:1.4. The minimum size at first maturity for females was measured as 74 mm TL, and 50% of the female population were mature at about 110 mm (TL_{50}%). It was also determined that female shrimps had developed their eggs between June to October, with two peak spawning periods between June-July, and August and October.

Keywords: Shrimp, Reproduction, Size at first maturity, Mediterranean Sea

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[DOR: 20.1001.1.15622916.2015.14.2.3.2]

Introduction

Most penaeid shrimps are short-lived animals living in highly variable inshore areas during their juvenile phase. They are frequently subjected to strong environmentally driven variability in recruitment and stock size (Garcia, 1985).

Speckled shrimp (*Metapenaeus monoceros*), is a commercially important prawn in the back waters and estuaries, and spread up to about 75 m dept in the continental shelf region (Sukumaran *et al*., 1993). It has been recorded in the eastern Mediterranean, the east coast of Africa, Madagascar, the Red Sea, all coasts of India, Pakistan and Ceylon, and Malaysia as far as the Straits of Malacca. Aquaculture of this species is practised in India, whereas wild stocks are mostly caught from Egypt, Israel, Cyprus and Eastern Mediterranean waters (Rao, 1989; Sukumaran *et al*., 1993; Nandakumar and Srinath, 1999; Yılmaz *et al*., 2009). Shrimp fisheries has an increasing importance trend in the fishing industry of Turkey, and artificial culture of suitable species is carried out intensively throughout the world (Tull *et al*., 2003, Yılmaz *et al*., 2009). Speckled shrimp which is predominantly found in the penaeid fauna of the North-eastern Mediterranean Sea is a potentially important species for the Turkish aquaculture (Kumlu, 2001). Although, the biology and fisheries of this shrimp had been studied in other Mediterranean countries, studies conducted in Turkey are mainly focused on trawl net selectivity, but limited studies had been done on the population structure and reproductive biology (Kumlu *et al*., 1999; Can *et al*., 2004; Bayhan *et al*., 2005; Manasirli and Avsar, 2008; Bayhan and Gokce, 2010). Therefore, this reaearch aimed to study the reproductive biology and the size at first sexual maturity of the female *M. monoceros*, which are important information for the fisheries management of this species. It is also aimed to understand whether geographical distribution cause any differences between populations of different localities.

The present study was carried out in the context of management plans, and particular emphasis has been placed on quantifying the spawning periods and the size at first sexual maturity.

Materials and methods

This study was carried out in the North-eastern Mediterranean Sea (36º17′-36º40′N, 35º20′-36º17′E) by monthly sampling of speckled shrimps from November 2009 to October 2010. The specimens were caught by a typical Mediterranean deep trawl net (nominal value of 22 mm cod-end mesh size) from the depths of 20 to 80 meters.

Samples were collected randomly from each haul as recommended by Holden and Raitt (1974), kept in ice and transported to the laboratory. A total of 784 individuals were collected for this study, and females and males of *M. monoceros* were sorted by examining the visible gonads, thelycum or petasma, (Fischer *et al*., 1987). Then carapace length (CL, to nearest 0.1 mm; from the posterior margin of the orbit to the anterior margin of the carapace) as well as the wet body and ovarian weight (BW, OW, to the nearest 0.01 g and 0.0001 g,

[DOR: 20.1001.1.15622916.2015.14.2.3.2]

respectively) of these specimens were measured and recorded in the laboratory.

In order to estimate the spawning season, the monthly mean Gonadosomatic Index (GSI) values were calculated using the formula given by Gibson and Ezzi (1978) as:

$GSI = (GW/(TW - GW)) \times 100$

[GW = gonad weight; TW = total weight]

Fulton's Condition Factor (CF) was also calculated using the formula given by Htun-Han (1978) as:

$CF = (W/L^3) \times 100$

[W=weight; L=length] to assess the maturity and the condition of *M. monoceros*. The maturity stage was determined using the unaided eye, and the degree of maturity was divided into the following five categories by modifying the scale proposed by Rao (1989) and Kumlu *et al*. (1999):

Stage I (immature): ovaries thin, transparent, and difficult to see;

Stage II (maturing): ovaries visible and wider, the general colour is yellowish;

Stage III (mature): ovaries clearly visible and wider; their colour is light green;

Stage IV (ripe): the ovary is dark green or brownish green and is clearly visible through the exoskeleton;

Stage V (spent): ovaries spent or post-spawned.

To calculate the size at first maturity, the size group in which the ratio of mature individuals (Stages III, IV, V) to immature ones (Stages I and II) reaches 50% was utilized (Sparre and Venema, 1992).

Seawater temperatures and salinity were measured with a probe of YSI® model (±1◦C and ±1 ppt).

Results

Temperature and salinity

The highest temperature measured was 29.07°C in August and the lowest 16.36°C in February, with a mean of 21.96±4.68°C. Maximum and minimum salinity values were measured in January and August as 39.79 and 37.50 ppt, respectively, with a mean of 38.57±0.66 ppt (Fig.1).

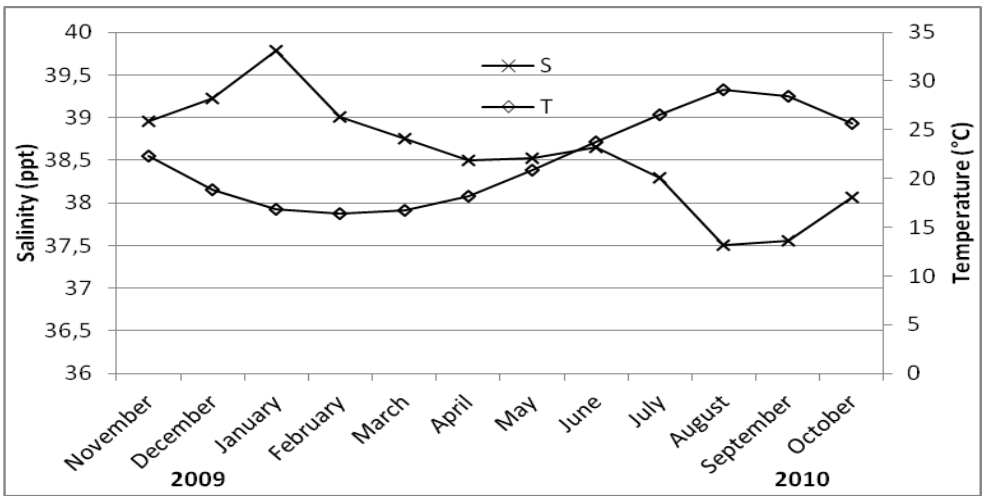

Figure 1: Monthly changes in mean temperature and salinity in the North-eastern Mediterranean.

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Sex ratio

The sex of all 784 specimens were determined visually as described before. Among them 457 specimens were females (58.30%) and 327 specimens were males (42.70%), and the overall male: female ratio was calculated as 1:1.4 (Table 1). Analysis of the number of males and females per month (χ^2) showed that the difference was statistically significant (χ^2=34.2, p=0.001), and the females dominated the males in the North-eastern Mediterranean Sea (Table 1).

Table 1: Number of individual males and females and their sex ratio in different months of the sampling period.

Months	Male	Female	Total	Sex ratio (M/F%)
November 2009	72	100	172	58.14
December 2009	56	87	143	60.84
January 2010	33	35	68	51.47
February 2010	3	1	4	25
March 2010	13	17	30	56.67
April 2010	45	60	105	57.14
May 2010	18	24	42	57.14
June 2010	61	69	130	53.08
July 2010	21	13	34	38.24
August 2010	5	47	52	90.39
September 2010	0	2	2	100
October 2010	0	2	2	100

Spawning period

In order to determine the spawning period, the individual gonad weight of 457 female specimens were measured, and their maturity stages were determined (Fig. 2).

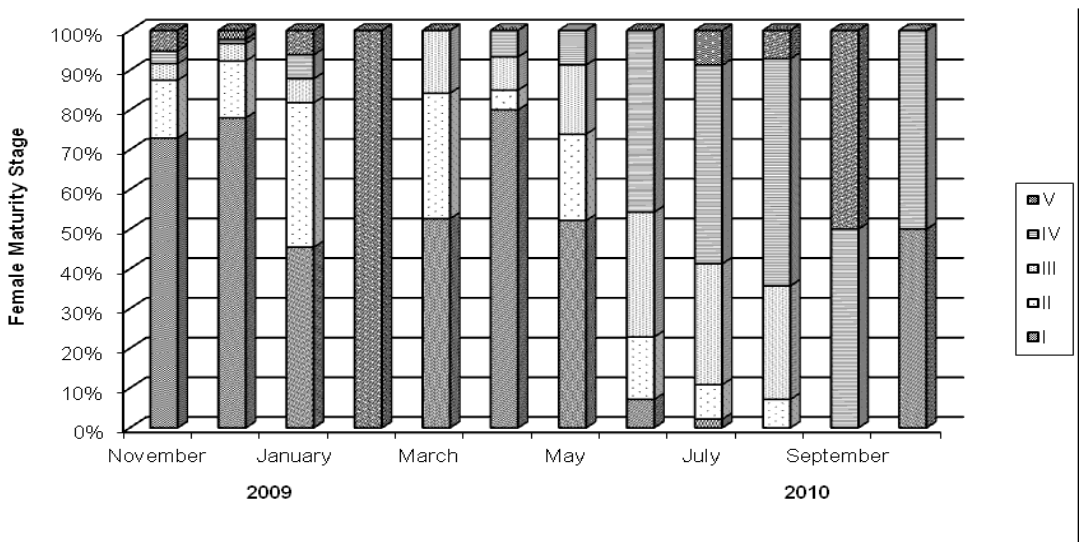

Figure 2: Monthly changes of female maturity of *M. monoceros*. I. immature; II. maturing; III. mature; IV. ripe and V. spent.

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As it can be seen from Fig. 2, the mature female individuals were found from April to January, but mature female individuals were mostly seen between June and October.

The gonadosomatic index and Fulton's condition factor values were also calculated and shown in Fig. 3.

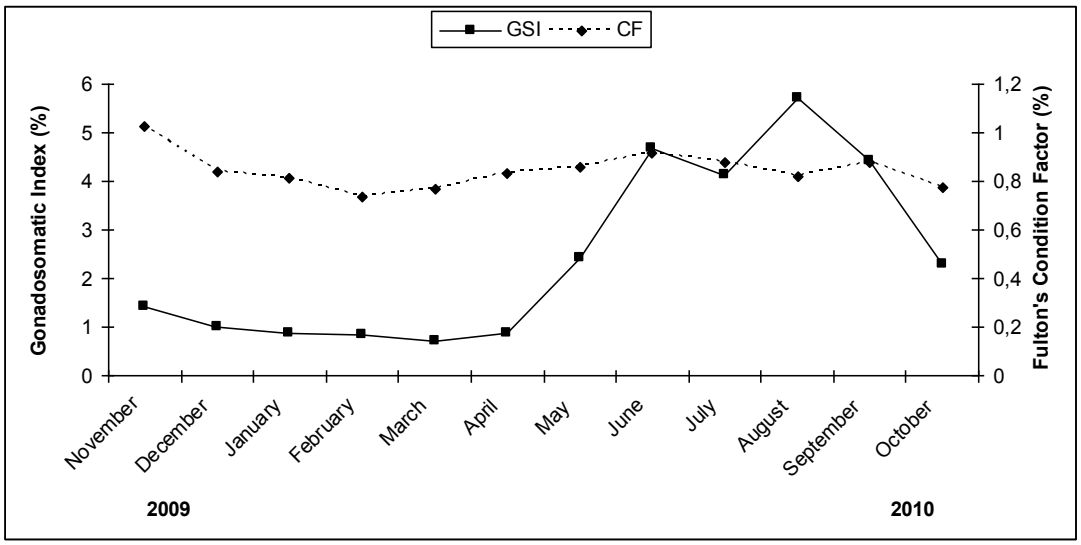

Figure 3: Monthly changes of gonadosomatic index and fultun's condition factor of females *M. monoceros*.

As it is evident from Fig. 3, the GSI values started to increase from May with the gradual development of gonads, and reached the highest value in August. After the start of spawning activity, GSI values decreased until December.

Analysis of the condition factor (CF) in detail, revealed that the CF is the highest in November and lowest in February, which also had the lowest recorded temperature (16.36ºC; Fig. 1). However, after February, the CF increased until June, in which the spawning started to decrease again until the following spawning period (from June and August-October). This observation showed that the speckled shrimp needs a good condition of nourishment before every spawning period, and understandably consumes its reserves through the reproduction period.

Considering Figs. 2,3, it can be concluded that the spawning of speckled shrimp females occurred during the period from June to December in the North-eastern Mediterranean Sea, particularly in July and August-October.

Size at first maturity

The smallest female with a ripe ovary had 88.2 mm TL, and the largest size was 153.0 mm TL. The smallest size at first maturity was found by plotting the total length and the percentage of mature females (at ovarian stages III, IV, V) as shown in Fig. 4.

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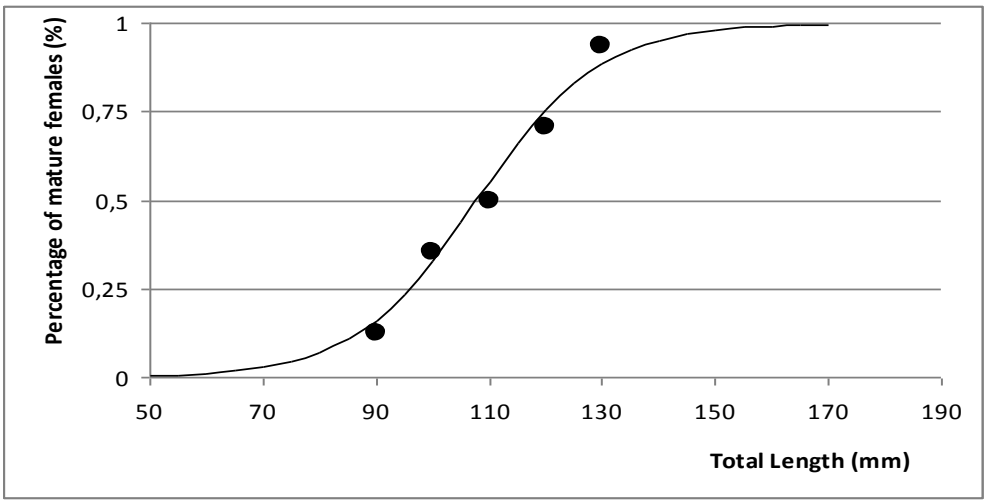

Figure 4: Size at first maturity (50%) for female *M. monoceros*.

The size at first maturity for females of this species was found to be 74 mm TL_{25} and 110 mm TL_{50} as a result of measurements performed over 457 female specimens.

Discussion

In this study, the male: female ratio of spackled shrimp from The North-eastern Mediterranean Sea ranged from 1:30 to 1:0.25. These results are very close and similar to some previous studies. Rao (1989) reported that this ratio varied monthly from 1:3.2 to 1:0.29 for the spackled shrimps from the Kakinada coasts of Indian waters. Nandakumar and Srinath (1999) stated a ratio of 1:2.9 for the specimens from Cochin waters in India, while Nandakumar (2001) gave 1.3:1 for the same region; and finally Yılmaz *et al*. (2009) reported a ratio of 1:2.8 for the specimens from Antalya coast and expressed that the difference was statistically significant from the ideal 1:1 ratio. Although our result was different to some extent from previous studies, the females number was generally higher in our study as well. Some researchers, such as Rao (1967) and Dall *et al*. (1990), stated that the females of penaeid shrimps generally dominate the population and this is a general population characteristic of this family, which is in agreement with our results. Some researchers attribute this domination to the low fecundity rate (Rao, 1967).

It was observed that the size at first (50% TL) maturity of *M. monoceros* at The North-eastern Mediterranean Sea was 110 mm TL in females (Fig. 5). George (1970) and Nalini (1976) reported 118 mm TL_{50} at Cochin. George *et al*. (1988) found 106 mm TL_{50} for males and 135.5 mm TL_{50} for females in the Karwag area. Rao (1989) reported 96 mm TL_{50} for males and 110 mm TL_{50} for females and Nandakumar (2001) found 95 mm TL_{50} for males and 114 mm TL_{50} for females in the Kakinada area. According to Yılmaz *et al*. (2009) maturity size of *M. monoceros* in the Antalya Gulf, was 75 mm TL_{50} and 115 mm TL_{50} for males and females respectively.

As can be easily seen, the maturity sizes obtained in the present study were, on the whole, smaller than those reported by

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previous studies, but similar to George *et al*. (1988) and Rao (1989). The differences can be explained by the variable catching depths, temperature and salinity differences, and notably geographical and environmental differences (Fig. 1). It is a well-known fact that there is a close relationship between size at first maturity and temperature (Tom *et al*., 1988; Mori *et al*., 2000).

In general, our study showed that the reproductive and spawning activity of *M. monoceros* in the North-eastern Mediterranean Sea seems to be continuous from the beginning of summer to the end of autumn (from June to December), with two peaks of spawning activity, one in July and the other in August-October, (Fig. 3). George (1959, 1962) reported that females performed the spawning activity within two periods, June-August and September-December; Nalini (1976) found it to be from September to April; and Srivatsa (1953) reported it between February and April for Cochin coasts; Rao (1989) reported throughout the ten months for the speckled shrimps off the Kakinida coast; Nandakumar (2001) observed the reproduction activity all year round off the Indian coast,, with two peak periods, one in December-April and the other in August-September. Yılmaz *et al*. (2009) reported that females from Antalya Coast performed the spawning activity in November-January.

The reproductive activity of female *M. monoceros* takes place at very different times in various geographical areas. Differences could be due to the different hydrographical characteristics of the various areas (Mori *et al*., 2000; Nandakumar, 2001).

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