Some Reproductive Aspects of *Melicertus kerathurus* (Forskäl, 1775) (Decapoda, Penaeidae) Inhabiting the Gulluk Bay (Aegean Sea) of Turkey

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Abstract

Some reproductive aspects of *Melicertus kerathurus* (Forskäl, 1775), a shrimp of high commercial value, were studied in Gulluk Bay throughout the fishing season from May 2005 to November 2005. A seasonal reproduction pattern was observed from May to October with a high percentage of mature females occurring between May and July, when water temperature was relatively high. During the study, a total of 700 specimens were captured: 414 (59.1%) females and 286 (40.9%) males. The largest female and male were 22.0 cm and 17.3 cm, respectively. The minimum size attained at first maturity for females was estimated to be 3.1 cm carapace length (CL) and 12.3 cm total length (TL). Sexual differences related to the length-weight relationship were noted. The onset of sexual maturity for females was estimated to be $CL_{50\%}$ = 4.8 cm and $TL_{50\%}$ = 17.8 cm.

Key words: *Melicertus kerathurus*, sexual maturity, length/weight relationship, Aegean Sea.

INTRODUCTION

The commercial shrimp species in Turkish coastal waters are *Penaeus semisulcatus*, *Melicertus kerathurus, M. hathor, Marsupenaeus japonicus, Metapenaeus monoceros, M. stebbingi* , *Parapenaeus longirostris* , *Trachypenaeus curvirostris*, *Aristaeomorpha foliacea* , and *Plesionika heterocarpus* [1,2]. *M. kerathurus* lives in shallow marine and estuarine waters (down to 40 meters) on sandy-mud bottoms [3]. In Turkey, this species is distributed in coastal areas of the Marmara, Aegean, and Mediterranean Sea [1]. Gulluk Bay is an important shrimp fishing area in Aegean Sea and *M. kerathurus*, a highly commercially important species, is caught by fisherman mainly using trammel nets and trawls in this area in western Turkey [4].

Studies on biological aspects of penaeid shrimps in Turkey are scarce. Among these, only four studies [2, 5-7] are concerned with their biology, whereas the rest dealt with their systematic. Although the biology and fisheries of *M. kerathurus* have been studied in other countries [8-15], there is only one investigation dealing with seasonal trends of reproduction for this species in Izmir Bay, Aegean Sea [7]. The purpose of the present study is to determine the size of morphological and physiological sexual maturity, seasonal variation of spawning intensity, size frequency and length-weight relationship of *M. kerathurus* inhabiting the Gulluk Bay within one fishing season. These results can be used to create a more appropriate fishery policy in the region. Local fishing grounds should be more wisely exploited in order to stop the ongoing decline of living stocks.

MATERIAL AND METHODS

During the fishing period of 2005 (May 10-November 10) a monthly sampling (n= 100) schedule was followed on board of a commercial fishing boat. Shrimps were collected on a boat (8 m long) using trammel nets with an inner mesh size of 40 mm (polyamide 0.24 mm twine diameter) and an outer mesh size of 220 mm (polyamide 0.50 mm twine diameter) and by means of a bottom trawl net (14 mm mesh cod ends). Fishing operations by trammel nets were carried out between 10 and 20 m depths and trawl shots were undertaken at three stations at depths of between 30-50 m (Figure. 1). During each cruise, surface water temperature and salinity were measured.

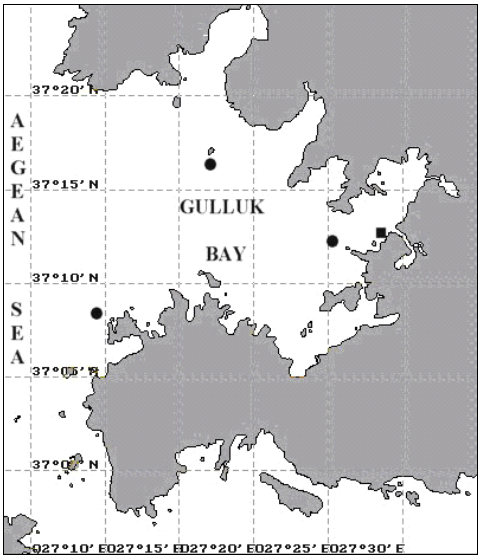

Figure 1. Sampling areas in Gulluk Bay: ●, by trammel nets; ■, by bottom trawl net.

All sampled individuals were sorted according to sex, weighed to the nearest 0.01 g, measured for their carapace length (CL) from the postorbital margin to the posterior end of the mid-dorsal line of the carapace, and for total length (TL) from the tip of the rostrum to the end of the telson, using Vernier callipers. The samples were used to determine size frequency, length-weight relationship, size at first sexual maturity, and sexual stage of the shrimps. Size at sexual maturity, corresponding to 50% of the mature females, was determined by fitting the curve representing the proportion of the females according to the logistic function $P = 1 / (1 + \exp(-r(L - L_m))$ as proposed by King [16]. Females were classified into four different developmental stages according to their degree of sexual maturity: immature, early maturing, nearly ripe, and ripe, according to ovary size and colour [8]. The condition factor was determined by using formula $K = (W/L^3) *100$, where K = condition factor, W = weight in g, and L = total length in cm [17].

RESULTS

Salinity and temperature

The salinity of the bay did not change much during the course of this study. Salinity was slightly higher in summer (39.0-39.5 ppt) than in spring (38.0-38.7 ppt). The water temperature was higher than 25°C in summer (July-August) but lower than 20 °C in spring (May) and autumn (November).

Length frequency distribution

During this study, a total of 700 specimens of *M. kerathurus* were analysed, 414 (59.1 %) being females, 286 (40.9 %) males. The mean size for females was 17.4 ± 1.9 cm TL, ranging from 11.7 cm to 22.0 cm, with a mode at 17 cm (Fig. 2); for males 14.4 ± 1.3 cm TL, varying from 11.0 cm to 17.3 cm TL with a mode at 15 cm (Fig. 3). The mean size of females was significantly larger than the mean size of males ($P < 0.05$). The largest female and male were 22.0 cm and 17.3 cm, respectively.

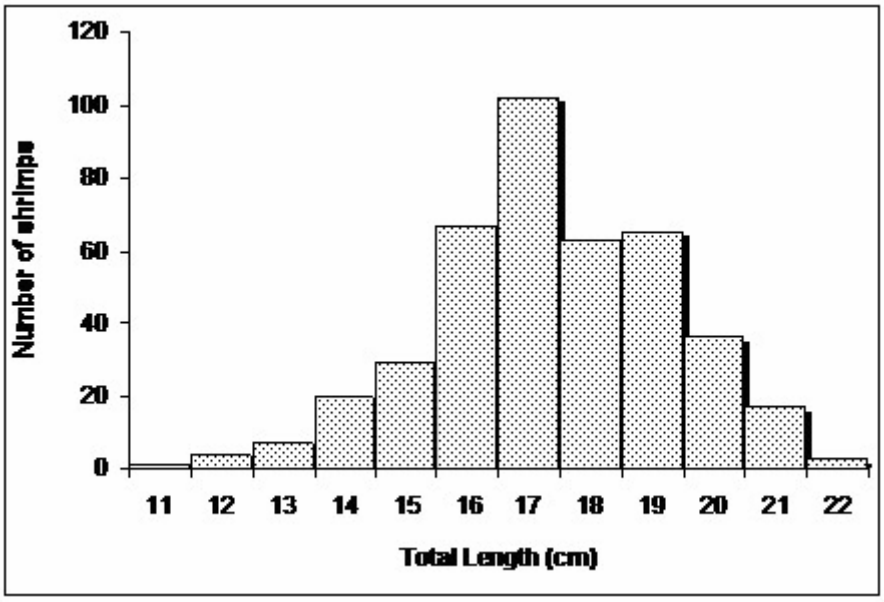

Figure 2. Size frequency distribution of females of *M. kerathurus* (n = 414).

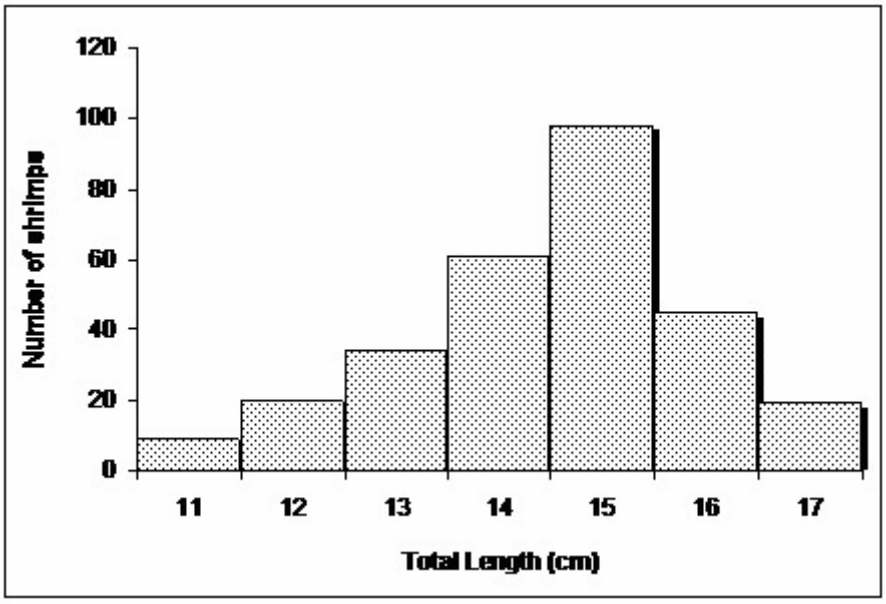

Figure 3. Size frequency distribution of males of *M. kerathurus* (n = 286).

Length at first maturity

When carapace and total length and percentage of mature females (at ovarian stages 3 and 4) were plotted, the smallest size at first maturity occurred in the size of 3.1 cm CL or 12.3 TL in July. The onset of sexual maturity was estimated to be 4.8 cm as $CL_{50\%}$ or 17.8 cm as $TL_{50\%}$ for females (Fig. 4 and 5). 100% of mature females were found after the size of 5.6 cm CL and 21.0 cm TL, indicating a high proportion of post-spawning activity in *M. kerathurus* at larger sizes.

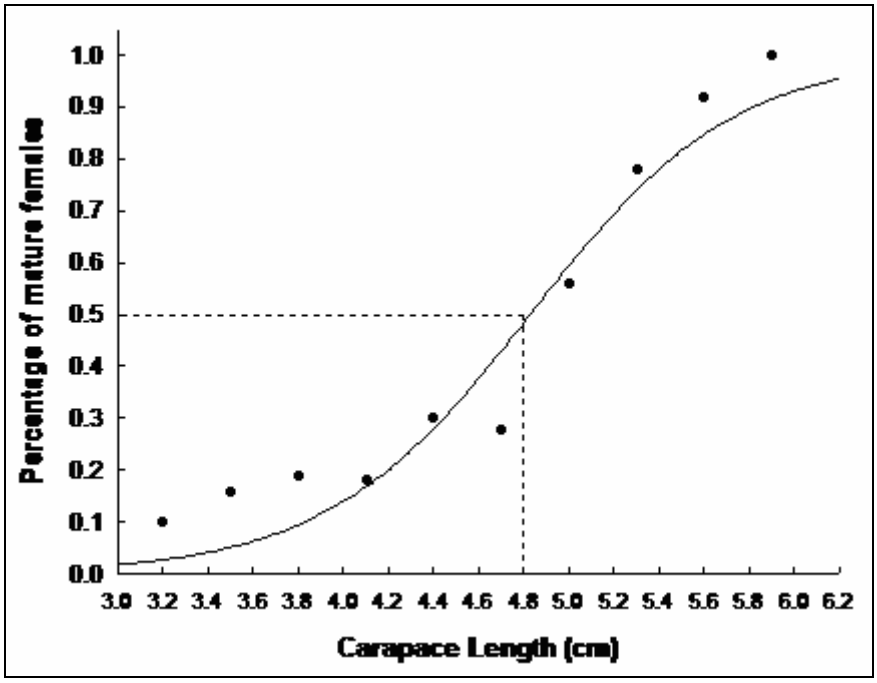

Figure 4. Relationship between percentage of mature females *M. kerathurus* and size (CL)

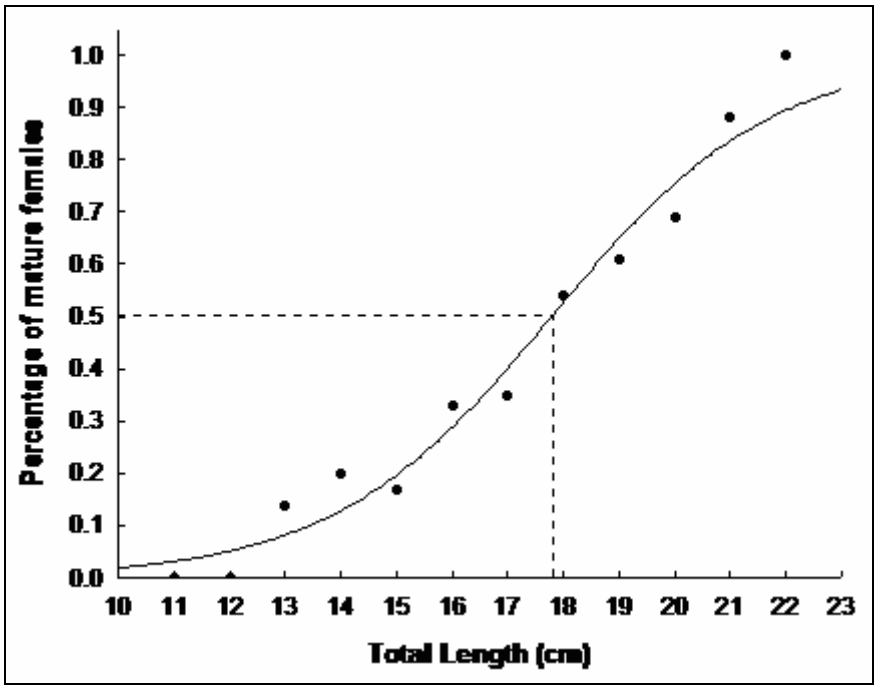

Figure 5. Relationship between percentage of mature females *M. kerathurus* and size (TL)

Length-weight relationship

Length-weight relationships were determined separately for males and females of *M. kerathurus* by the general formula $W = aL^b$, where W is weight in grams, L length in cm, and a and b are constants to be calculated. The length-weight relationship for males and females were calculated and are given in Figs. 6 and 7. From visual inspection of the length-weight relationship curves, allometry in growth is observed in both males and females. The condition factor of the females (0.81) was higher than that of the males (0.78).

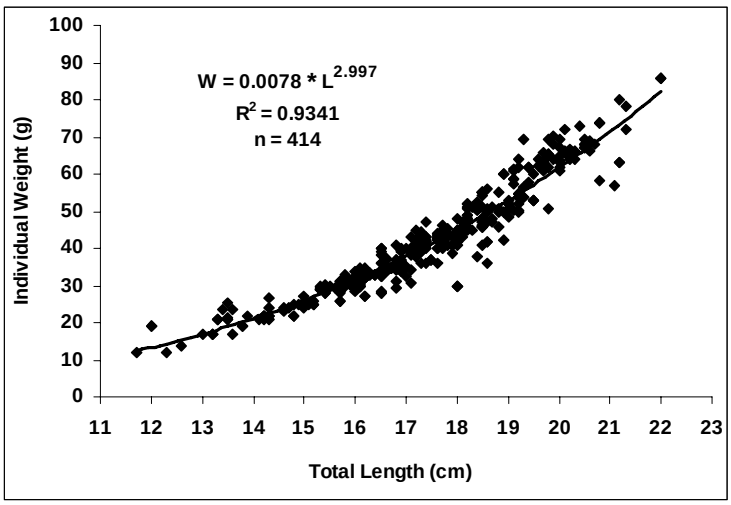

Figure. 6. Length-weight relationship for females of *M. kerathurus*.

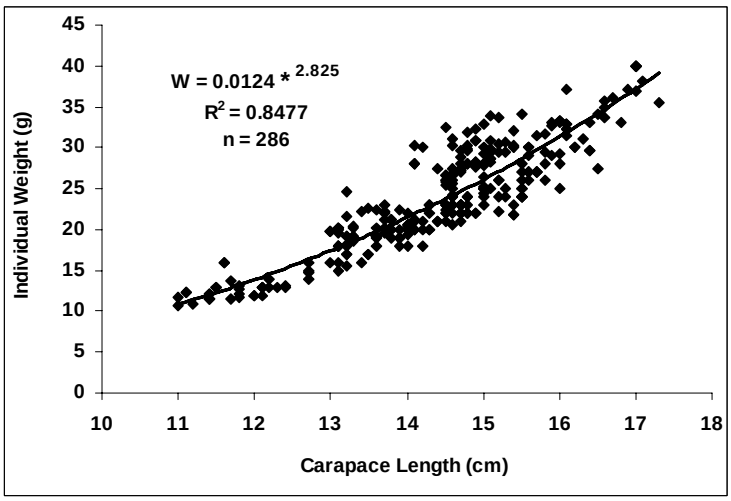

Figure 7. Length-weight relationship for males of *M. kerathurus*.

Seasonal maturity

A higher percentage of mature females was observed between May and July than in the other months over the course of the study. Most of the females (79.2%) were about to spawn in July. Nevertheless, the percentage of mature females in August, September and October was recorded as 33.3%, 18.2% and 8.6%, respectively (Fig. 8). The percentage of mature females in November was observed as 3.2%.

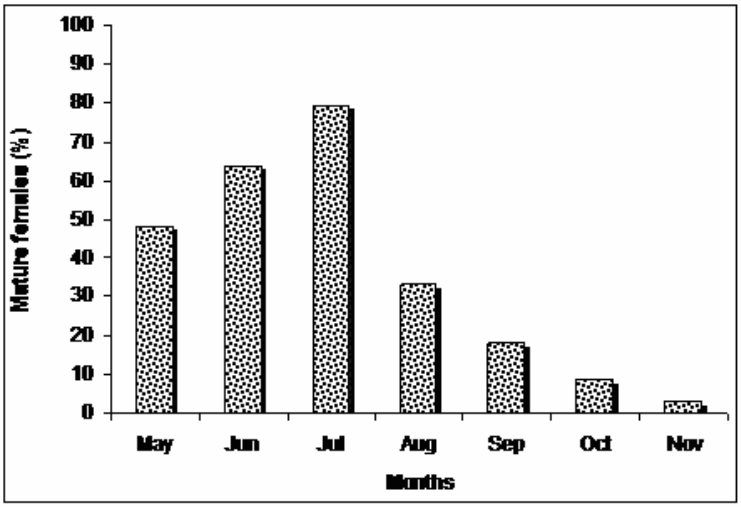

Figure 8. Percentage of mature females of *M. kerathurus*.

DISCUSSION

A seasonal reproduction pattern of *M. kerathurus* was observed from May to October, with a high percentage of mature females in May to July. Concomitantly with rising water temperatures in the summer months (May to August), the proportion of active spawners in the population increased. The finding of females with ovarium stages 3-4 indicates that *M. kerathurus* females spawn in Gulluk Bay. Similar observations were reported from Greece (from late April to late September), Italy (from May to August), Spain (from May to September), Tunisia (from June to October) and Turkey (Izmir Bay) (from April to September) [7-9,12-14]. Thus, these results suggested that the spawning seasons of *M. kerathurus* populations on the coast of Mediterranean countries are affected by water temperature. In addition, the results suggest that *M. kerathurus* can spawn 2 or 3 times during the reproductive season, with intervals of about 2 months.

The mean size of females (17.4 cm TL) was significantly greater than that of males (14.4 cm TL). The largest female and male encountered during the current study were recorded as 22.0 cm TL (86 g) and 17.3 cm TL (48 g), respectively. Sexual differences related to length-weight relationships were found as well: the slope was flatter in males (b = 2.825) than in females (b = 2.997). Similar results were also noted for the same species in previous studies in Izmir Bay and Tunisia [7,10].

The bionomics of *M. kerathurus* in Gulluk Bay can be compared with Izmir Bay. As shown in this study, the minimum size at first sexual maturity recorded was 3.1 cm CL and 12.3 TL for females. In Izmir Bay, the minimum size at first sexual maturity recorded was about 3.9 cm CL and 14.1 TL cm for females [7], higher than in this study. These finding are in agreement with the 3.0 cm (CL) size reported for the population in Greece [14]. However, minimum size at first sexual maturity (as TL) was reported to be higher (17.4 cm, only for females with stage 4) in Italy for the same species [13]. The size at which 50% of the population is mature may be a good indicator of the size of large-scale spawning in the population. The onset of sexual maturity was estimated at $CL_{50\%}$ = 4.8 cm and $TL_{50\%}$ = 17.8 cm for females in Gulluk Bay. $CL_{50\%}$ size is in good agreement with the 4.5 cm and 4.6 cm size reported for Greece and Izmir Bay [7,14]. However, $TL_{50\%}$ size of *M. kerathurus* reported in the present study (17.8 cm) is smaller than the size (20.2 cm) reported by Scordella & Lumare [13] for Italy, but is larger than that (12.0 cm) reported by Rodriguez [8] from Spain.

The spawning season of *M. kerathurus* in Gulluk Bay is extended for one month as reflected by the ratio of mature females in September and October when compared with Izmir Bay. In the present study, ratio of mature females was recorded as 18.2% and 8.6% in September and October, respectively (Fig. 8). But the rations for the same month in Izmir Bay recorded as 6.6% and 0.9%. The differences between these studies may be related to environmental and biological factors. It is known that the spawning season of shrimps may change from one geographic area to another [5]. The variation could also be due to perceived differences in population abundance and structure, because of variation in the characteristics of catchability depending on fishing gears used on different fishing grounds, differences in growth rate between areas, or possibly because different criteria were used to estimate the proportion of mature individuals [7].

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