



WWJMRD 2017; 3(8): 60-65  
www.wwjmr.com  
International Journal  
Peer Reviewed Journal  
Refereed Journal  
Indexed Journal  
UGC Approved Journal  
Impact Factor MJIF: 4.25  
e-ISSN: 2454-6615

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## Relative Growth of *Erugosquilla massavensis* and *Clorida albolitura* (Stomatopoda, Squillidae) from Northeastern Mediterranean of Turkey

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### Abstract

A total of nine stomatopod crustaceans have been reported from the eastern Mediterranean, with the eight from the Turkey coasts and three from the Levantine coast of Turkey (*Squilla mantis* (Linnaeus, 1758), *Erugosquilla massavensis* (Kossmann, 1880), *Clorida albolitura* (Ahyong & Naiyanetr, 2000)). *E. massavensis* is the most successful Red Sea immigrant, and it is now the dominant eastern Levantine stomatopod. At this research, carapace length/total length- weight relationship of 2 Eritrean mantis shrimp, *E. massavensis* and *C. albolitura* was studied in Iskenderun Bay, in the Northeastern Mediterranean of Turkey. Samples were collected monthly from July 2014 to June 2015 (except February), using bottom trawl net into 0-50 m. *E. massavensis* samples were caught all studied time; except winter, *C. albolitura* samples were caught only in July, October and May's months. A total of 572 specimens of the *E. massavensis* and 38 specimens of the *C. albolitura* were collected. Morphometric equations for the conversions of total length and weight, carapace lengths were constructed for males, females, combined sexes for *E. massavensis* and *C. albolitura*. The *b*-values for total length (TL)-weight (W) in males and females for *E. massavensis* were 2.738 and 2.725 respectively and for carapace length (CL)-total length (TL) they were 1.041 and 0.978, relatively. The *b*-values (total length-weight) were determined for combined sexes of *E. massavensis* and *C. albolitura* as: 2.771, 2.982 relatively. In both species, the relative growth of weight and total length was found highly positively allometric. However, carapace length showed negative allometry in females of *E. massavensis*.

**Keywords:** *Clorida albolitura*; *Erugosquilla massavensis*; Erythrean Stomatopod; Length/length-weight Relationships; North-Eastern Mediterranean; Turkey

### Introduction

The bio-diversity of the Mediterranean is definitively altered by the introduction of new species. Since the first review of exotic species in the Mediterranean, the studies on this topic have concentrated. A taxonomic classification of the exotic species showed that the immigrant phylum most frequently reported is Mollusca (33%), Arthropoda (18%), Chordata (17%), Rhodophyta (11%), and Annelida (8%). As far as can be deduced, the majority of aliens in the Mediterranean penetrated through the Suez Canal (Eritrean aliens) (53%), and an additional 11% was introduced primarily through the canal and then spread by vessels. Many introduced species have established permanent populations and extended their range [1].

A total of 12 stomatopod species have been reported from the Mediterranean Sea, including two alien species namely; *Erugosquilla massavensis* (Kossmann, 1880) and *Clorida albolitura* (Ahyong & Naiyanetr, 2000) [2,3,4,5]. *E. massavensis* is the most successful Red Sea immigrant, and it is now the dominant eastern Levantine stomatopod. It is abundant at depths of 20-40 m [3, 6]. Furthermore, in the Levantine coast native mantis crab *Squilla mantis* was reported to have been displaced by *E. massavensis* [4]. *E. massavensis* (Kossmann, 1880) reported for the first time in Mersin and Antalya coast of Turkey by Holthuis [7]. *E. massavensis* is distributed along the entire Mediterranean coast of Turkey, with a westernmost limit extending as far as Fethiye. The distribution range of *E.*

*massavensis* in the eastern Mediterranean basin extends the southern coast along the Aegean Sea, and is reported from the Sea of Marmara [2]. Also, this species have recorded Israel, Lebanon, Syria, Cyprus, Crete, Rhodes [8, 9].

*Clorida albolitura* is the second species of Eritrean stomatopod to enter the Mediterranean. It was first noted from Ashdod, the southern coast of Israel [3] and it has been reported the bay of Iskenderun on the Mediterranean coast of Turkey [10] and it has been reported from the varying depths between 22-61m in Iskenderun Bay [11]. *C. albolitura* is a smaller species than *E. massavensis*, reaching 75 mm in length [3]. Stomatopods Mediterranean, South Africa, America, China, and in particular, the global trawl fisheries are economically important resources and are used commercially in Japan [12, 13, 14]. However, the species of Stomatopoda on coasts of Turkey have rarely been a subject of scientific interest [4]. Published biology and population dynamics information on stomatopod is very limited. There is only one study about *E. massavensis* in Antalya Bay, the northeastern Mediterranean coast of Turkey [6]. *E. massavensis* is sufficiently abundant in potential commercial interest. Furthermore, other alien species, self-sustaining population of *C. albolitura* occurs in the Southeastern Mediterranean. However, populations of two Eritrean stomatopod species are still unknown, due to poor knowledge of the biological parameters in the northeastern Mediterranean. The present study reported to accomplish the relative growth of two Eritrean mantis shrimps, *E. massavensis* and *C. albolitura*, in Iskenderun Bay on the Turkish Mediterranean coast. Therefore, length and weight are two keys in the biology of species to the individual and population levels. Understanding on relative growth is helpful for further studies of the biology of *E. massavensis* and *C. albolitura* along northeastern Mediterranean coast of Turkey.

### Materials and methods

A total of 572 specimens of the *E. massavensis* and 38 specimens of the *C. albolitura* were collected from commercial bottom trawl net in the Iskenderun Bay northeastern Mediterranean Sea (coastal waters of Turkey). Field samples were obtained from a survey conducted for a small shrimp trawl (15 m head rope with 14 mm-mesh cod end) towed for 45 minutes at depths of between 0 and 50 m (Fig 1). Each monthly survey sampled crabs from July 2014 to June 2015 (except February). All individuals were kept on ice until laboratory.

In the laboratory, sex was identified by the presences or absence of penes at the base of the pereopods on the eighth thoracic segment [15]. All individuals were weighed to the nearest 0.01 g and total length (TL) and carapace length (CL) (nearest mm) of each specimen were measured. The sex ratio was estimated and statistical differences between changes in the number of females and males were

determined using the chi-square test for *E. massavensis*.

The study of stomatopod' relative growth was made by the biometric analysis of the three measures. Three sizes were used namely the total length (TL, from the base of the rostrum to an anterior edge of the median notch of the telson), other carapace lengths (CL, from the base of the eye groove to a posterior mid-dorsal edge of the carapace), and wet weight (W). The regression analysis was achieved to explain the relationships between various morphometric characters. The total length was chosen as the main reference measurement [16]. The log-transformed data was used to attain the linearity of relationship ( $\text{Log } Y = \text{Log } a + b \cdot \text{log } X$ ). Each regression analysis was also estimated the coefficient of determination ( $R^2$ ) and significance ( $p \leq 0.05$ ). Statistical equality of morphometric relationships between sexes was evaluated using ANCOVA at  $P \leq 0.05$  level of significance. Tangent values were estimated by converting the inverse tan of respective "b" values to degrees. Allometries were determined using these tangent values. Allometry was decided as positive when the tangent values overstepped  $45^\circ$  and negative when the tangent values lowered  $45^\circ$  [16].

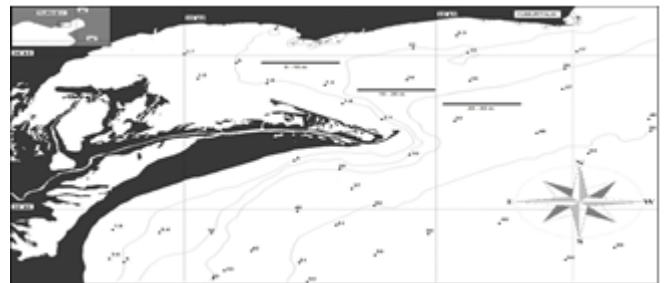


Fig. 1: Study area (Yumurtalik Cove-Iskenderun Bay)

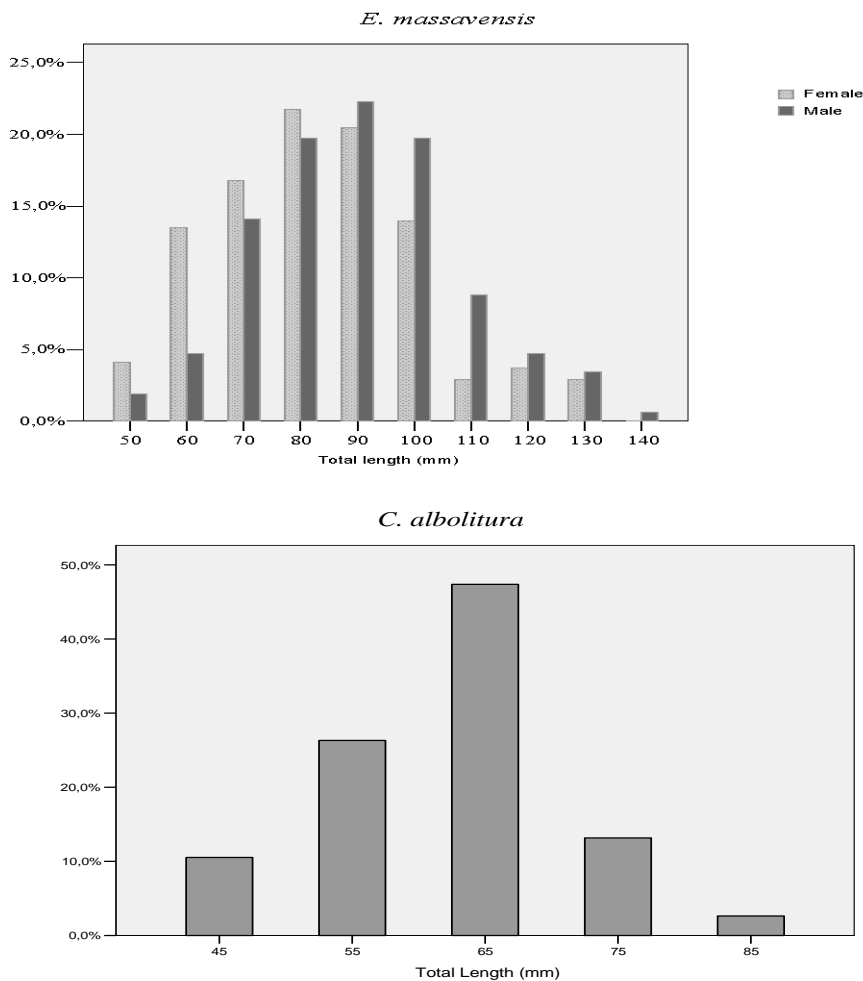
### Results & Discussion

The total number of specimens sexed of *E. massavensis* was 572, of which 244 females (42.7%), 319 male (55.8%), and juvenile 9 (1.5%). The chi-square test showed that this mean significant deviation from the expected ratio of 1:1 ( $\chi^2 = 9.9$ ,  $df = 1$ ,  $p < 0.05$ ).

The estimates of biometrical data for *E. massavensis* and *C. albolitura* are shown in Table 1. The total length (TL) of males ranged from 60.50 to 153.00 mm with a mean of  $104.68 \pm 17.91$ , and females ranged from 60.80 to 149.40 mm with a mean of  $97.40 \pm 18.08$  mm for *E. massavensis*. A significant difference in mean total length ( $t$ -test =  $-4.76$ ,  $d.f. = 561$ ,  $p < 0.05$ ) was found between sexes (Fig 2). The mean weight of the males and the females was  $18.23 \pm 9.21$  g and  $14.53 \pm 7.97$  g, respectively. There was a significant difference between sexes in overall weight ( $t$ -test =  $-5.01$ ,  $d.f. = 561$ ,  $p < 0.05$ ). The total length (TL) varied between 36.15 and 77.03 mm with a mean of  $56.75 \pm 8.86$  and the mean weight  $4.03 \pm 1.92$  g of *C. albolitura* (Table 1, Fig.2).

**Table 1:** Descriptive statistical values for various measurements of *E. massavensis* and *C. albolitura* (carapace length, cl; total length, tl; weight, w)

Species	Sex	n	CL (mm) mean±SD (min-max)	TL (mm) mean±SD (min-max)	W (g) mean±SD (min-max)
<i>Erugosquilla massavensis</i>	Female	244	22.33±4.55 (10.50-37.06)	97.40±18.08 (60.80-149.40)	14.53±7.97 (3.25-49.52)
	Male	319	24.56±4.77 (10.40-35.29)	104.68±17.91 (60.50-153.00)	18.23±9.21 (3.80-53.11)
	Juvenile	9	14.75±2.37 (12.00-20.20)	63.27±4.59 (57.83-70.80)	3.92±1.30 (2.81-6.85)
	All	572	23.45±4.90 (10.40-37.06)	100.92±18.80 (57.83-153.00)	16.43±8.95 (2.81-53.11)
<i>Clorida albolitura</i>	All	38	12.35±2.08 (7.50-16.34)	56.75±8.86 (36.15-77.03)	4.03±1.92 (0.88-9.86)



**Fig. 2:** Total Length frequency distribution for *E. massavensis* and *C. albolitura* from Yumurtalık Cove (Iskenderun Bay)

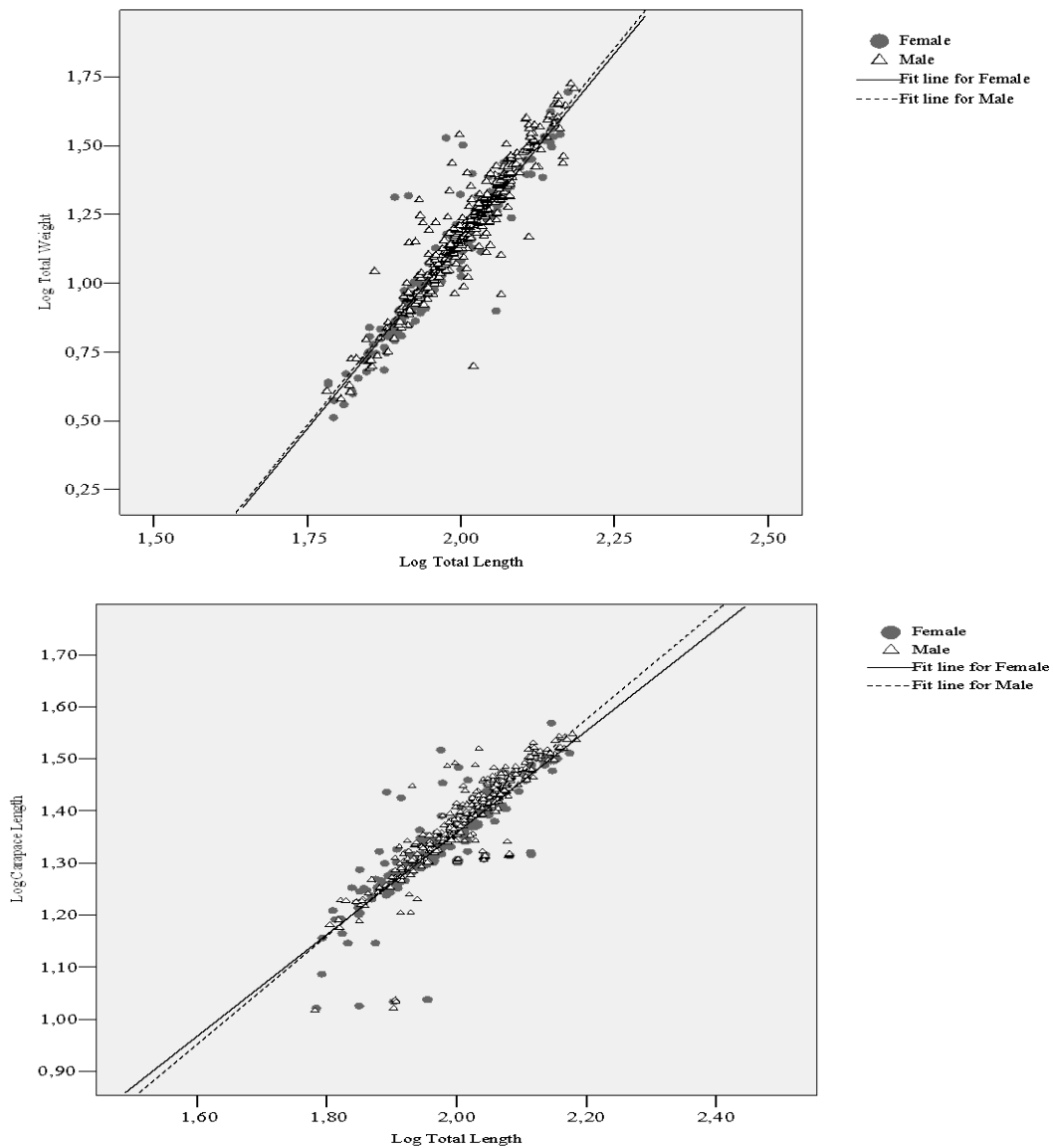
The results attained for the weight- total length (W/TL) and carapace length-total length (CL/TL) relationships, along with some descriptive statistics are given in Table 2, Fig 3 and Fig 4. The coefficient determination ( $R^2$ ) values were high (0.86); the only exception was carapace length in female of *E. massavensis* and significant ( $p < 0.05$ ) meaning very strong relationships between total length and weight for two species and carapace length for *C. albolitura*.

Concerning the type of growth, tangent values were maximum all cases. Weight and total length showed positive allometry for two species. However, carapace length showed negative allometry in females of *E. massavensis* (Table 2).

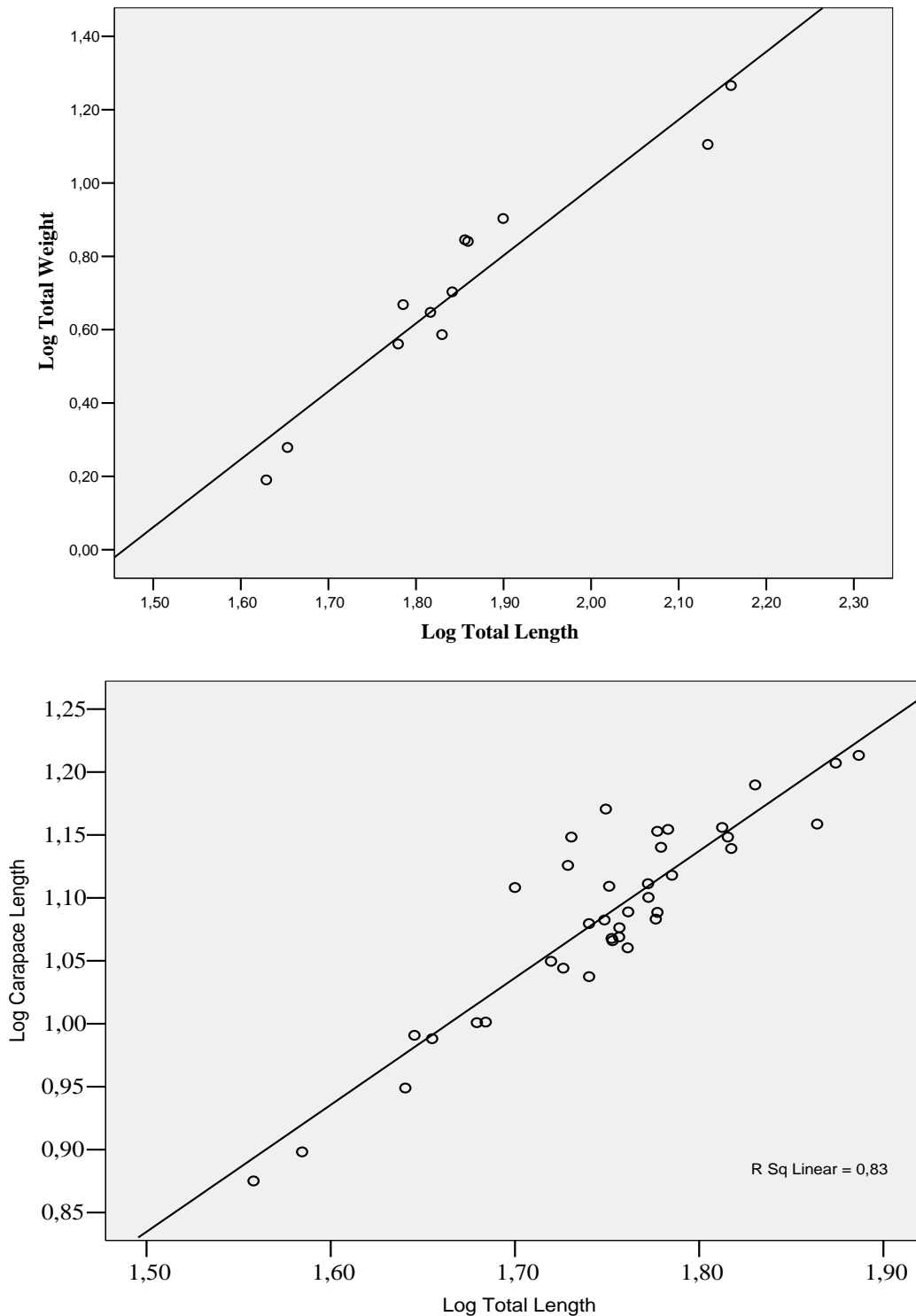
Growth of carapace length ( $F = 1.554$ ,  $p > 0.05$ ) and total weight ( $F = 0.023$ ,  $p > 0.05$ ) did not show significant variation between males and females for *E. massavensis*.

**Table 2:** Estimated parameters of relative growth. Intercept (a), Regression coefficient (b), Standard error (SE), coefficient of determination ( $R^2$ ), Angle of tangent and allometry for total weight (g), carapace length (mm) against total length of male (M), Female (F) and Total length (TL) *E. massavensis* and *C. albolitura*. \* Indicates significant ( $P \leq 0.05$ )

Species	Measures /TL	Sex	Intercept (a)	Slope (b)	S.E. (b)	CL(b)	$R^2$	Significance (p value)	Tangent	Allometry
<i>Erugosquilla massavensis</i>	W	M	-4.307	2.738	0.062	2.616-2.860	0.861	*	89,979	+
		F	-4.297	2.725	0.060	2.607-2.843	0.895	*	89,978	+
		T	-4.380	2.771	0.041	2.692-2.851	0,891	*	89,979	+
	CL	M	-0.714	1.041	0.032	0.978-1.103	0.771	*	89,944	+
		F	-0.598	0.978	0.040	0.899-1.057	0.711	*	44,362	-
		T	-0.681	1.024	0.024	0.976-1.069	0.768	*	89,944	+
<i>Clorida albolitura</i>	W	T	-4.658	2.982	0.145	2.689-3.275	0.922	*	89,969	+
	CL	T	-0.678	1.009	0.076	0.854-1.163	0.830	*	89,968	+



**Fig. 3:** Regression plots of Total weight and Carapace Length against Total Length of Male and Female *E. massavensis*



**Fig. 4:** Total Weight-Total Length (W/TL) and Carapace Length-Total Length (CL/TL) relationships for *C. albolitura*

In the study area, *E. massavensis* samples were caught all studied time, except winter, in the three depth range but *C. albolitura* samples were caught only in July, October and May's months. The total length (TL) of males ranged from 60.50 to 153.00 mm with a mean of  $104.68 \pm 17.91$ , and females ranged from 60.80 to 149.40 mm with a mean of  $97.40 \pm 18.08$  mm for *E. massavensis*. Sallam [17] said that carapace length of females ranged from 14.0 to 30.5 mm for Port Said, Egypt. It has been said that we found almost similar carapace length of females (10.5 to 37.06 mm) for cost of turkey.

The sex ratio obtained from this study showed significant deviation from the expected ratio of 1:1 ( $\chi^2 = 9.9$ , d.f.=1,

$p < 0.05$ ). The different result has been reported for Antalya Bay [6]. They concluded that the expected ratio of 1:1 no significant. However, biometrical data more or less similar reported for Antalya Bay [6] for *E. massavensis*. The mean weight of *E. massavensis* for Iskenderun Bay was higher than Antalya Bay. Sallam [17] (2005) reported that total number of females was almost similar to the total number of males. And, the ratio showed insignificant difference ( $\chi^2 = 36.8$ , d.f.=11,  $p > 0.05$ ).

Weight-length (W/TL) and carapace length-total weight (CL/TL) relationships indicated positive allometric growth *E. massavensis* population of Iskenderun Bay. This exhibits that carapace length and weight increase is superior to the

growth in total length. According to result's growth of carapace and total weight did not appear variation between males and females. Gökoğlu et al. [6], also a similar growth (allometry) in Antalya Bay. Nevertheless, they presented that the W/TL was indicated a negative allometric growth. Their result was very different from our study.

The total length (TL) ranged from 36.15 to 77.03 mm with a mean of  $56.75 \pm 8.86$  mm and the mean weight  $4.03 \pm 1.92$  g of *C. albolitura*. Weight-length (W/TL) and carapace length-total weight (CL/TL) relationships indicated allometric growth. There is no previous study comparing different body dimensions in relation to total length of *C. albolitura* in Mediterranean coast of Turkey.

In conclusion, the work concerned with the assessment of weight-total length (W/TL) and carapace length-Total length (CL/TL) in mantis shrimps from Yumurtalık Cove are poor. There is currently little published biological data about mantis shrimps in Turkey. This study is thought to be helpful for future studies, particularly fishery biologists or scientists and assessment of these fisheries. Further research must be conducted to determine the full dynamics of mantis shrimps on the Mediterranean coast of Turkey.

#### Acknowledgments

The authors are grateful to Cukurova University for funding was provided by Project number: SÜF2013BAP25

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